The Coal Tar Colours

of the

Farbwerke vorm. Meister Lucius & Brüning Hoechst on Main.

A. General Part.

1896.

Farbwerke vorm. Meister Lucius & Brüning
HÖCHST a/M

Lith. Anst. v. Hubert Köhler, München.

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The Coal Tar Colours,
their Properties and Reactions
and the
Methods of their Application.

1896.

fec. Franz Rank 95

PREFACE.

In the present work our aim has been to place before our customers, in a readily accessible and concise form, a tabular survey of all our colouring matters, together with information as to their properties and methods of application, and we hope thereby to meet a long felt want.

In consequence of the large number of colouring matters to be dealt with, and the great variety in the methods of applying them, we have deemed it desirable to divide the work into **two parts,** viz:

A, the **General Part,** which deals with the **colouring matters themselves,** their reactions and properties, and the various methods of fixing them on the different fibres and materials, and

B, the **Special Part,** in which the matter is arranged according to the various branches of the **dyeing industry,** and which comprises the practical application of the colouring matters and dyewares for certain definite purposes and requirements, it includes further the detection of colouring matters on the dyed fibre as well as references to the fastness of the dyes themselves.

So manysided indeed is the subject of dyeing, including as it does a large number of important and distinct branches, that it is practically impossible to treat it in an entirely exhaustive manner; neither is it possible to state, in connection with each colouring matter, for what particular purposes it may or may not be employed; indeed soexceedingly varied are the uses to which our colours are now being applied, necessitating therefore equally varied requirements, that we are not able to follow them. Nevertheless we trust we have succeeded in placing before our readers a useful book of reference concerning many questions of dyeing, and one which our friends may often be able to consult with advantage.

We may say that the **second part** is already in preparation and will be published as soon as possible.

Hoechst on the Maine, Autumn 1896.

Farbwerke vorm. Meister, Lucius & Brüning.

Abbreviations.

^{0}Tw = degrees Twaddell.
^{0}C = degrees Centigrade.
^{0}F = degrees Fahrenheit.
cc = cubic centimetre.
g = gram.
h = hour.
k = kilogram.
l = litre.
$^0/_0$ = per cent.

The numbers 1 : 5, 1 : 10, 1 : 50, etc. referring to solutions and mixtures of certain substances, denote the number of cubic centimetres which contain one gram of the substance in question.

The per centages of dyestuff, acid, Glauber's salt, etc. given in the various receipts for dyeing, always refer to the weight of the material to be dyed.

The Coal-tar Colours.

In the following tables we present a general survey of our various colouring matters, giving in a concise manner the various marks or brands introduced to the trade, their solubility, the methods of applying them to wool, cotton, and silk, and their employment in different branches of industry. — In these tables the different marks of the same colouring matters, as well as really distinct colouring matters, which are used for the same or similar purposes, are placed together. The accompanying dyed or printed patterns are intended not only to show the colours obtained with the respective colouring matters, but also the material for which they are most suitable.

We have arranged the colouring matters in the following five groups according to their most predominant properties, reactions, and methods of application:

A. **Basic Colours.** These are usually the hydrochlorides or zinc-double-chlorides, and occasionally the sulphates, oxalates, or nitrates of colour-bases of the Diphenyl and Triphenyl-methane, Acridine, Oxazine, Thiazine, Safranine, Induline, and certain Amido-azo Colours. — Their solutions are precipitated by tannic acid, hence cotton is dyed with the aid of this mordant, whereas wool and silk are dyed direct.

B. **Resorcine Colours.** These are the potassium or sodium salts of various bromine or iodine compounds of fluoresceïn or chlorinated fluoresceïn. — Their aqueous solutions are precipitated by mineral acids, and by agitation with ether they are readily abstracted from the acid liquid. Their solutions exhibit a characteristic fluorescence. They dye the animal fibres without the aid of metallic salts as mordants.

C. **Acid Colours.** These are usually the sodium or calcium salts of the sulphonic acids of basic colouring matters. — Their solutions are not precipitated with tannic acid, they cannot be abstracted by means of ether when acidified, and are not permanently decolourised by boiling with zinc powder and hydrochloric acid. They dye wool and silk direct, in an acid bath.

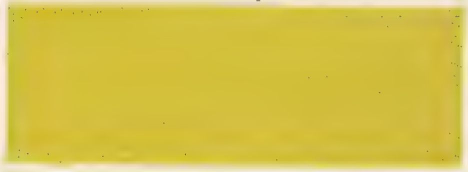
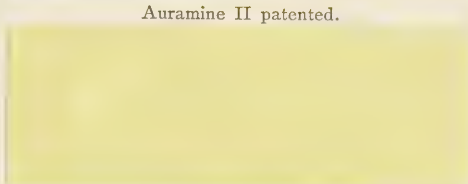
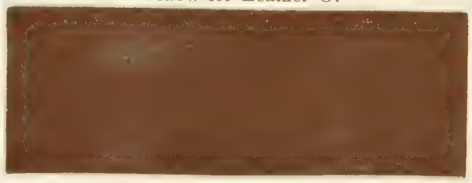
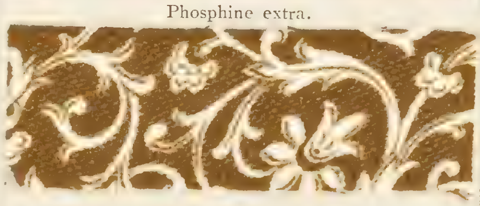
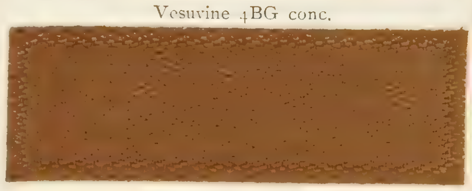
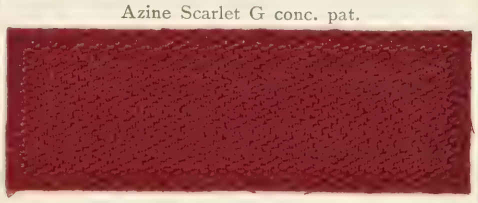
D. **Nitro- and Azo-Colours.** These are the sodium salts of the sulphonic acids of Nitro, Amido-azo and Oxy-azo Colours. — Their solutions are not precipitated with tannic acid, they cannot be abstracted by means of ether when acidified, but they are permanently decolourised by boiling with zinc powder and hydrochloric acid. Like the Acid Colours they dye wool and silk direct, in an acid bath. The Chromotropes, Chrome Brown, and Chromogen I must also be placed in this group by reason of their constitution, but in consequence of the method of their application in dyeing they may be regarded as forming a connecting link with the following group.

E. **Mordant Colours.** These are the free colour-acids, sodium salts, or bisulphite compounds of Alizarin, Nitroso, and certain Azo-Colours, or the sodium salts of the sulphonic acids of these bodies. — Their characteristic feature is that they can only be employed as dyestuffs in conjunction with metallic salts as mordants.

F. **Certain colouring matters are produced direct upon the fibre,** and in the following tables these constitute a separate group; they are really **insoluble Azo-Colours,** which are formed on the fibre itself by the interaction of their constituent parts, viz: a Diazo-compound and Naphthol.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Auramine (conc., O, I, II) patented.	1884	Add acetic acid to the colour and dissolve in warm water, heated at most to 80° C. (175° F.) Boiling water must on no account be used.	Dye in a neutral bath at 60°—70° C. (140°—160° F.)	Mordant with tannin and tartar-emetic, and dye; occasionally used for topping or shading dye-wood colours and direct-dyeing cotton colours. The dye-bath should never be hotter than 60°—70° C. (140°—160° F.)	Dye in neutral bath with addition of boiled-off liquor at 60°— 70° C. (140°—160° F.); add the colour solution gradually; brighten with acetic acid.
Phosphine P, superior, extra, new) **Yellow for Leather** (O) **Brown for Leather** (O) **Brown** (A)	1862	Add acetic acid to the colour, and dissolve in boiling water; the lower qualities which are less soluble require the use of methylated spirit. — The solutions should be filtered before use.	Dye in a bath slightly acidified with acetic acid, at 70°—80° C. (160°—175° F.)	Mordant with tannin and tartar-emetic, and dye.	Dye in neutral bath or one containing boiled-off liquor and slightly acidified with acetic acid; brighten with acetic or tartaric acid.
Vesuvine (O, 2RV, 2R, conc., 3R superior, B, BB, 3BM, 4GB conc., extra yellow) **Cutch Brown** (D, G) **Dark Brown** (M, MB) **Chrysoïdine** cryst.	1863	Add acetic acid and dissolve in boiling water; filter before use.	Dye in a bath slightly acidified with acetic acid, at 70°—80° C. (160°—175° F.)	Dye on tannin and tartar-emetic mordant, or even on unmordanted cotton; also used for topping catechu, wood, and direct-dyes. — Saddening with copper sulphate alone or mixed bichromate of potash increases the fastness of the colour.	Dye in a bath containing boiled-off liquor slightly acidified with acetic acid; brighten with acetic or tartaric acid.
Safranine (O, conc., AN extra, GGS) **Cotton Scarlet** (O) **Azine Scarlet** (GO, G conc.) patented.	1863/65 1895	Add acetic acid, and dissolve in boiling water; filter before use.	Dye in a soap-bath at 60°—70° C. (140°—160° F.)	Dye on tannin and tartar-emetic mordant; also used for shading alizarin and dye-wood-colours, and very largely for topping direct-dyes on cotton.	Dye in a bath containing boiled-off liquor slightly acidified with acetic acid; brighten with acetic or tartaric acid.

Colours.

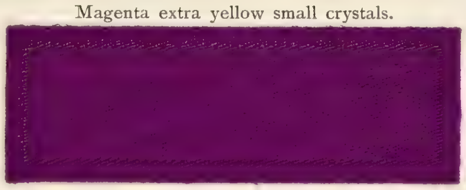
Employment	Dyed Patterns
In **Cotton-dyeing** used for yellows fast to washing and to light, very important for loose cotton-wool, yarn and cloth. On tannin and tartar-emetic mordant employed alone or in combination with other Basic-Colours for producing yellow, brown, green, olive and scarlet dyes. — In **Silk-dyeing** chiefly for shading and for specially bright colours. — In **dyeing wool-cotton, silk-cotton** and **silk-wool Unions** largely employed, for shading either the cotton or the silk. — In **Calico-printing** used occasionally as a steam-colour, important as a yellow dye on tannin mordant. — In **printing wool, silk, wool-cotton** and **silk-cotton Unions.** — In **Leather-dyeing** used either alone or along with other dyestuffs. Much used in dyeing **Jute, Cocoanut-fibre, Straw, Feathers, Artificial Flowers.** Largely employed in **Paper-colouring.** — In the manufacture of **Pigments** (Lakes) chiefly used in combination with other Basic-Colours. — For colouring **Spirit Varnishes, Confectionery,** and **Hectograph Inks.**	Auramine O patented.  Auramine II patented. 
In **Cotton-dyeing** on tannin and tartar-emetic mordant, it is seldom used; more employed in dyeing **Union Fabrics.** — In **Calico-printing** used for compound colours and for shading, in steam tannin-colours; also for buff grounds, and as a good yellow for discharge-colours. — In the printing of **Wool, Silk,** and **Union Fabrics,** also in **Discharge-colours** printed on Azo-dyes, it is largely employed. — Very much used in **Leather-dyeing** either alone or along with other colours and for all kinds of leather, in the production of various shades of yellow and brown. — Seldom used in the manufacture of **Paper** and **Lakes,** more frequently in dyeing **Feathers** and **Artificial Flowers,** also in the preparation of yellow coloured **Spirit Varnishes.** Employed in colouring **Soap** and **Candles.**	Yellow for Leather O.  Phosphine extra. 
In **Cotton-dyeing** much used alone and along with other Basic Colours, also on unmordanted cotton, and for topping shades dyed with Catechu, Dyewoods, and the Direct Cotton Colours, especialy in piece-dyeing, but also for yarn, when special fastness to washing is not required. — In **Calico-printing** finds limited use as a steam tannin-colour. — Little used for **Silk,** but frequently for **Silk-Cotton,** also **Wool-Cotton Unions;** employed also in **printing** union fabrics. — Used for **Jute, Cocoanut-fibre,** and **Straw.** — Largely employed in dyeing **Leather, Skins. Feathers,** and **Artificial Flowers.** — Very extensively used in the **Paper Trade** for colouring paper-pulp, dipping, and paper-staining. — Employed also for dyeing **Wood,** for the manufacture of coloured **Spirit Varnishes,** and **Lakes,** and for colouring **Soap.**	Vesuvine 4BG conc.  Dark Brown M. 
In **Cotton-dyeing** extensively used alone on loose cotton-wool, yarn, and cloth, but especially in combination with other Basic Colours, for producing a good washing red fast to light. — In **Silk-dyeing** much employed especially for pale shades. — Of great use in the dyeing of **Union Fabrics** for shading the cotton in wool-cotton or silk-cotton Unions, and for shading the in silk-wool unions. — In **Calico-printing** either alone or along with other basic dyestuffs in steam-colours. — In printing **Wool-Cotton Unions, Silk-Cotton Unions** and **Silk.** — In dyeing **Jute, Straw, Feathers,** and **Leather,** and especially in colouring **Paper.** — In the manufacture of coloured **Spirit Varnishes, Candles,** and **Artificial Flowers.**	Azine Scarlet G conc. pat.  Safranine AN extra. 

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing — Wool	Methods of Dyeing — Cotton	Methods of Dyeing — Silk
Magenta (extra large cryst.; extra yellow, large and small cryst.; large and small cryst.; large and small cryst. double refined, etc.) Also low class magentas mostly containing phosphine, such as **Cerise, Grenadine, Maroon, Cardinal,** which are employed in a similar manner. The red marks of **Methyl Violet** (5R, 4R, 3R, 2R, R) are also used in the same manner as magenta. **Primula** (R, B)	1856	Somewhat difficulty soluble in water, and readily crystallising out from the solution. It is best to add acetic acid to the colour and then to dissolve in boiling water. Another method which is highly recommended is to mix to a paste on the water-bath with twice its weight of glycerine and four times its weight of methylated spirit and then to add boiling water. All solutions should be filtered before use, and those which have been standing for some time must be heated again.	Dye in neutral bath at 70°–80° C. (160°–175° F.) with or without addition of soap (1%). The brightest shades are obtained with addition of olive-oil soap. — On wool magenta is almost invariably used as a self-colour, and only occasionally for the production of compound shades.	Dye on tannin and tartar-emetic or stannic chloride mordant, or occasionally on oleate of alumina mordant. — Used also for shading alizarin claret, catechu, and wood-colours, and for topping the direct-dyes.	Dye in a bath containing boiled-off liquor slighthy acidified with acetic acid, or in a fresh soap-bath; brighten with acetic or tartaric acid, but not with sulphuric acid. — By an after-treatment with tannin solution the colour is made fast to washing with water
New Magenta (O patented).	1891/92	Much more soluble than ordinary magenta, and hence has not the troublesome property of soon crystallising out from its solutions.	Same as Magenta.	Same as Magenta.	Same as Magenta.
Rosazeine (O, extra, B, B extra patented).	1888	Somewhat readily soluble in boiling water; when using calcareous water its solution is facilitated by the addition of a little acetic acid.	Dye with the addition of acetic acid to the bath, adding 10% for a fresh bath, 5% acetic acid (50% strength) for an old bath. The dyebaths are not exhausted and should be kept for further use. If necessary one may also dye in an ordinary acid bath with addition of sulphuric acid and Glauber's Salt.	On tannin and tartar-emetic mordant the shades are dull and bluish, on oleate of alumina mordant they are very bright and fiery pinks or carmine-reds.	Dye at the boil in a very slightly alkaline or neutral bath containing boiled-off liquor; brighten with tartaric or acetic acid.

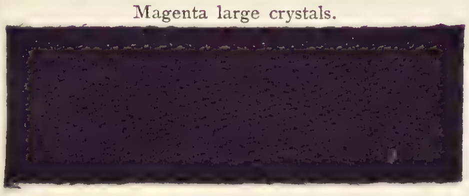
Colours.

Dyed Patterns	Employment

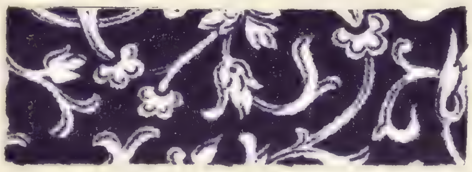
Magenta extra yellow small crystals.



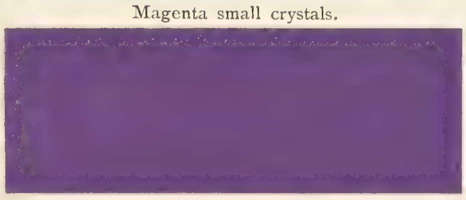
Magenta large crystals.



Magenta extra large crystals.

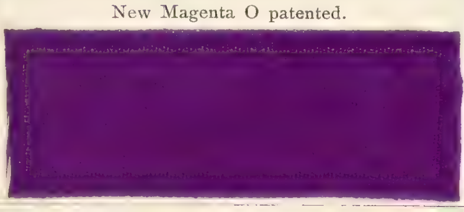


Magenta small crystals.



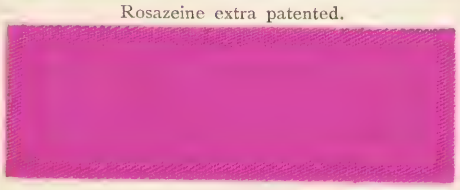
In **Wool-dyeing** seldom used, except as a self-colour for slubbing intended for pink mixtures in knitting yarns, occasionally for coloured fancy threads in yarns, also for zephyr-yarns, fancy yarns, and for light woollens and worsteds intended for export. — In **Cotton-dyeing** much used either alone or along with other colours on tannin (e. g. sumach) mordant; also for shading alizarin, dye-wood, and catechu-dyes; also for topping direct-dyes on cotton. — In **Silk-dyeing** very largely employed, both alone and along with other colours for various shades of plum, Bordeaux, garnet-red, etc. either on yarn or cloth. — Very useful also for silk-cotton and for silk-wool unions. — In **Calico-printing** used alone and along with other basic dyestuffs for steam-tannin-colours and for dyeing on tannin mordant; also as an addition to steam catechu colours, and for shading steam alizarin colours. — In **Wool** and **Silk printing,** also in the printing of wool-cotton unions, also silk, wool, and cotton, chiefly as a steam-tannin-colour either alone or in mixtures. — In **Leather-dyeing** magenta, and especially such as contains phosphine, is largely used for all kinds of leather, either alone or with other dyestuffs. — It is also pretty largely used for dyeing **Jute, Cocoanut-fibre** and **Straw,** because it is fixed without mordanting. — In **Paper-dyeing** it is used for colouring paper-pulp, also for dipping, and paper-staining. — In the manufacture of **Lakes** it is precipitated as a tannin, soap, and caseïn lake; used also for shading scarlet and eosine lakes, or the lead and barium lakes of Acid-Colours; also for colouring and brightening such pigments as bole, ochre, green-earth (lime-red), and china-clay. — For colouring shellac **Spirit Varnishes** magenta alone is not useful, but in combination with Brilliant Green it gives a fine black. — It is also used for the production of dark blue and black **Hectograph Inks,** also in combination with Brilliant Green. — As a resinate or oleate of the colour-base it is also employed in the colouring of **Candles** and **Wax.**

New Magenta O patented.



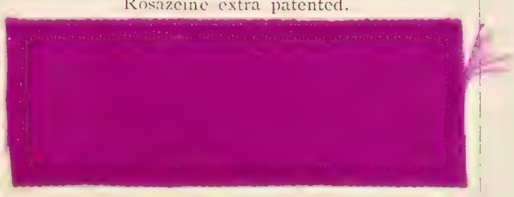
It yields a shade which is slightly bluer even than the bluest shades of magenta. It is applied in all the different industries above enumerated in the same manner as magenta. Its greater solubility causes its solutions to be free from deposits and there is less risk of spotting the goods, hence New Magenta has replaced ordinary Magenta for many purposes.

Rosazeine extra patented.



Rosazeine B extra patented.

Rosazeine extra patented.



In **Wool-dyeing** occasionally used on loose-wool for tinting scoured and also stoved whites; in yarn-dyeing it is used alone or with other dyestuffs for delicate pinks on all kinds of yarn; also on piece-goods especially muslin-de-laines and fine flannels for pink, and in combination with Chromotrope 2R, Orange II, and Scarlet, for producing fiery shades of cochineal scarlet. It is much used for piece-goods containing silk. — In **Cotton-dyeing** seldom used, except occasionally in dyeing yarn. — In **Silk-dyeing** largely used for yarn, cloth, silk-cotton and silk-wool unions, either alone or in mixture with other dyestuffs; it gives exceedingly bright rose-pink and ponceau shades which are reasonably fast. — In **Calico-printing** as a self-colour for clear bright pinks, but far more important in **Wool** and **Silk-printing** for producing the purest and brightest pinks and crimsons; also used in discharge-colours in wool and silk printing. — Rosazeine is used also for **Fancy Leather** and **Paper.** — It is used in dyeing **Straw, Jute, Cocoanut-fibre** and **Artificial Flowers;** also to a large extent in **Leather Dyeing** because of the purity of the shades it yields. — It is not much used in the manufacture of pigment colours, but very largely for colouring **Spirit Varnishes** pink, carmine and scarlet. It is employed in colouring **Candles, Soap,** and **Food-stuffs.**

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Methylene Violet (3RA extra, RRA, BN) **Rosolane** (O, T, R paste, B paste)	1885/86	Add acetic acid and then dissolve in boiling water, filtering the solution before use.		Dye on tannin and tartar-emetic mordant.	Dye in a bath slightly acidified with acetic acid, with or without the addition of boiled-off liquor.
Methyl Violet (B, 2B, 3B, 4B, 5B, 6B chem. pure, superior, extra). **Crystal Violet** (O)	1861/66	Add acetic acid and then dissolve in boiling water; or, make into a paste with glycerine and methylated spirit and then dissolve in hot water. Filter the solutions before use.	Dye in a neutral bath at 70°—80° C. (160°—175° F.) without addition, or with addition of soap (1%). — Stoved wool is dyed to a white in a strong soap bath. If necessary Methyl Violet may also be dyed in acid bath with addition of sulphuric acid and Glauber's salt.	Dye on tannin and tartar-emetic mordant, or occasionally on tannin and stannic chloride mordant. — Used also for shading alizarin violet, wood-colours, and the direct-dyes.	Dye in a bath slightly acidified with acetic or tartaric acid, with or without the addition of boiled-off liquor. By after-treatment with tannin solution (sumach, or gall-nuts) the dyed colour is made fast to washing with water. It is also used for shading logwood blacks.
Methylene Blue (Cryst. chem. pure, BB, BB extra, BB conc., and B, B conc., RB, R, R conc., 2R, 3R, 5R, 6R, DBB, DBB extra, DBB, extra conc., DB, DR, I^a D) patented. **Marine Blue** (D2RX, BI, RI) patented. **Methylene Dark Blue** (RBN, 3BN) patented. **Methylene Indigo** (O, SS) patented. **Thionine Blue** (GO) patented.	(77) 1885/86	Add acetic acid and then dissolve in boiling water.	Dye in neutral bath at 40°—50° C. (105—120° F.) with addition of soap.	Dye on tannin and tartar-emetic mordant, also on sumach and iron mordant; also used for topping or shading wood and alizarin colours, and the direct-dyes.	Dye in a bath containing boiled-off liquor slightly acidified with acetic acid; brighten with acetic or tartaric acid.

Colours.

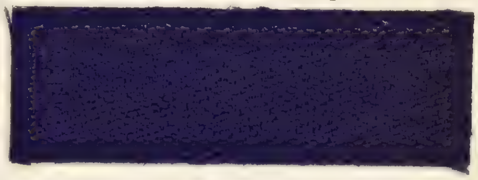
Employment	Dyed Patterns

In **Cotton-dyeing** it is specially used when fastness of colour is requisite. — In **Silk-dyeing** the Rosolane brands are chiefly used; much employed for shading the cotton in silk-cotton, and wool-cotton unions. — In **Calico-printing** it is used for steam-tannin-colours and for dyeing on tannin mordant. — In the manufacture of **Colour Lakes** it is used for producing fast violet colours for lithography. — It is used also for colouring **Spirit Varnishes.**

Methylene Violet RRA, powder.

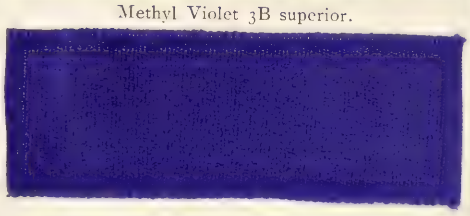
On **Wool** either as loose-wool, tops, yarn and cloth it is much used for tinting scoured and also stoved whites; on yarn and piece-goods it is used for dyeing brilliant violet colours for export trade; on piece-goods it is also used for giving a bloom to navy-blues, at the same time for covering burls. — In **Cotton-dyeing** it is much used either alone or mixed with other basic dye-stuffs on tannin and tartar-emetic mordant (especially for navy-blue); also for shading iron-alizarin-violet, dyewood and catechu colours, and for topping direct-dyes on cotton. In **Silk-dyeing** it is used alone and in mixtures on yarn and piece-goods of all kinds for producing a variety of shades of blue. — On **wool-cotton, silk-cotton,** and **silk-wool unions** it is much used for plain dyes. — In **Calico-printing** it is seldom used as a self-colour, but largely for shading navy-blues in tannin-colours and for brightening alizarin violets. — It is much employed in **printing wool, silk,** and **wool-cotton,** also **silk-cotton unions.** — In **Leather-dyeing** it is chiefly used for producing compound shades. — In the dyeing of **Jute, Cocoanut-fibre, Straw, Artificial Flowers,** and **Feathers** it plays an important part. — In **Paper-dyeing** it is very largely used both alone and in mixtures for dyeing paper-pulp, dipping and paper-staining. — In the manufacture of **Colour-Lakes** it is used alone and in mixture being precipitated with tannin, soap, or caseïn; it also serves for shading lakes made with Acid-Colours and dyewood-extracts, and for the brightening or dyeing of earth-colours. — It is employed for colouring **Spirit Varnishes,** also in the manufacture of **Writing** and **Hectographic Inks,** either alone or in mixture with other colours.

Methyl Violet 2B chem. pure.



Methyl Violet 6B superior.

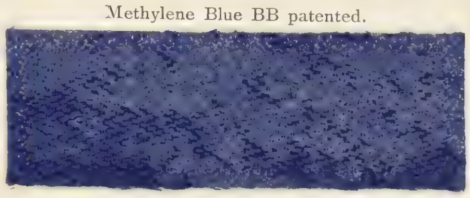
Methyl Violet 3B superior.



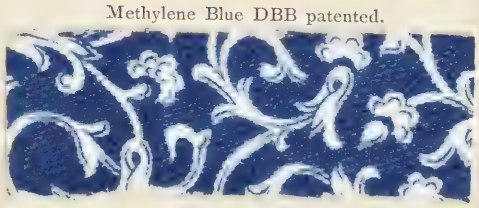
Methyl Violet 5B extra.

In **Wool-dyeing** it is used for zephyr and fancy yarns, and especially for stoved colours. — In **Cotton-dyeing** it is applied on tannin and tartar-emetic mordant, and is very largely employed because of the purity and general fastness of its colours; it is used for producing a great variety of blues and compound shades on loose cotton-wool, and on yarns intended either for weaving or knitting; it serves also for topping Alizarin Blue, Alizarin Yellow GG, and wood colours. — On **Silk** it is scarcely used for anything but brightening log wood black. — On **wool-cotton,** also **silk-cotton unions** it is used for shading the cotton; on **silk-wool unions** especially for «shots» it is employed for shading the silk. — In **Calico-printing** it is very largely used either alone or in mixtures as a steam-tannin-colour and for dyeing on tannin mordant; it is also much used in combination with Alizarin Yellow GG both for printed and dyed styles. — In **Wool** and **Silk printing** it is used for discharge-colours, and in the **printing** of **wool-cotton,** and **silk-cotton unions** for covers. — On **Leather, Jute, Cocoanut-fibre, Straw, Feathers, Artificial Flowers, Vegetable Ivory** and **Horn Buttons,** it is much used both alone and in mixtures. — In **Paper-dyeing** it is chiefly used for colouring the pulp intended for the finer qualities of paper. It is little used in the manufacture of colour-lakes, but is well liked for preparing **Writing** and **Ruling Inks,** and for the bands of type-writing machines.

Methylene Blue BB patented.



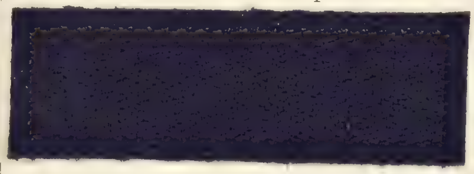
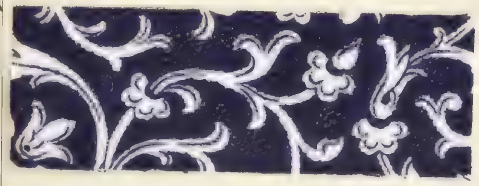
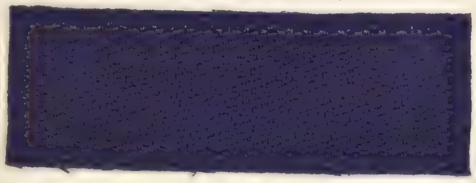
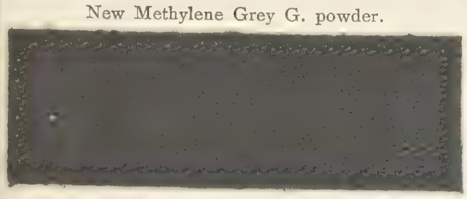
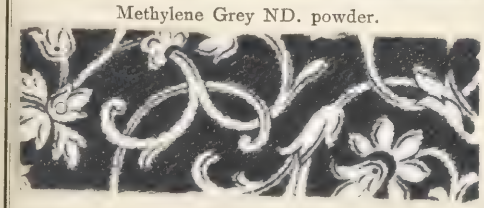
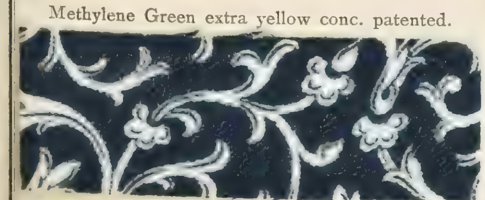
Methylene Blue DBB patented.



Marine Blue D2RX patented.

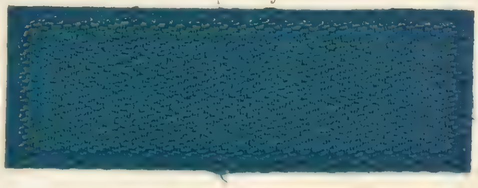
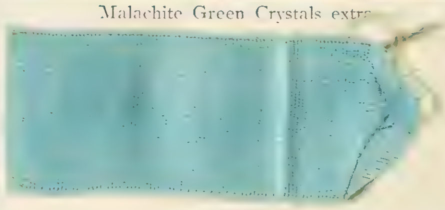
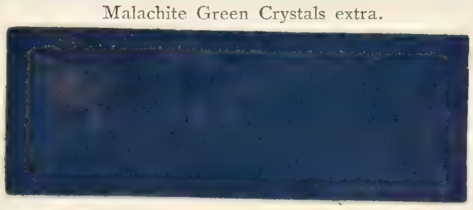
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing — Wool	Cotton	Silk
Indamine Blue (R, N, N extra, NB) **Direct Blue** (R, B, NB) **Anil Blue** (R, B)	1890	Add, or make into a paste with, acetic acid, and then dissolve in boiling water.		Dye on tannin and tartar-emetic or tannin and iron mordant. — Or, dye without mordant, with addition of 10°/₀ sodium acetate. — An after-treatment with bichromate of potash (3°/₀), or copper sulphate (2,5°/₀) and bichromate (1,5°/₀), renders the colour considerably darker and faster.	
Blue for Printing paste. (R, B, BB) **Blue for Printing** (R, B, BB powder) **Induline for Printing** (R, B powder and solution) **Acetinduline** (R solution) **Blue** (soluble in spirit)	1885	Heat on the water-bath with about four times the weight of the colour of ethyl-tartaric acid, till the solution is complete.		Used only in calico-printing by printing a mixture of the colour-solution and acetic acid and tannin thickening, then steaming and fixing in tartar-emetic bath.	
New Fastblue (3R cryst) **Fastblue for cotton** (3R, RR, R, RB, B, BB, 3B, 4B, 5B, 6B) **Fastblue for cotton paste** (B, BB)	1879	Add acetic acid to the colour and dissolve in hot water; filter the solution before use.		Dye on tannin and tartar-emetic or iron mordant, either alone or in combination with other basic dyestuffs.	
Methylene Grey (O, ND, NF, B, BF, G, R) **New Methylene Grey** (G powder, B paste)	1885/86	Add, or make into a paste with, acetic acid, and then dissolve in boiling water.		Dye on tannin and tartar-emetic mordant; for delicate light shades dye without mordanting, or pass through tannin and tartar-emetic baths after dyeing.	
Methylene Green (O, G, GG, extra yellow, extra yellow conc.) patented	1886	Add acetic acid to the colour, and then dissolve in boiling water.		Dye on tannin and tartar-emetic mordant; used also for topping alizarin dyes.	For shading blacks dye in a bath containing boiled-off liquor and slightly acidified with acetic acid.

Colours.

Dyed Patterns	Employment
Indamine Blue N extra powder.  Direct Blue NB powder. 	In **Cotton-dyeing** it is used for loose cotton-wool and yarn intended for goods in which the colours must be specially fast to washing and to light, more particularly for hosiery and embroidery yarns, as well as for weft yarns intended for figured cotton goods fast to washing, or for cotton furnitures and hangings. — In **Calico-printing** the various marks of **Direct Blue** are used for clear indigo shades satisfactorily fast to light and soap. — Used also in **printing Silk, wool-cotton,** or **silk-cotton unions,** and for **Melange-printing** on slubbing. — It is used for making a marking-ink for household purposes.
Acetinduline R solution. 	In **Calico-printing** very largely used either alone or shaded with Methylene Blue, Methyl Violet, and basic Green, as a steam-tannin-colour for blotches and covers, and for printing on both sides, in imitation indigo-styles. — Used also in printing **Jute-fabrics,** and in rainbow printing on cotton-yarn. — Printing Blue powder, and Spirit-Blue, are also used in the manufacture of blue, dark blue, and black **Spirit Varnishes.**
Fastblue for cotton RB. 	In **Cotton-dyeing** on yarn and piece-goods because of its great covering power and strength, (whenever special fastness to severe washing in alkaline solutions is not required). — In **dyeing silk-cotton,** or **wool-cotton unions** it is used for shading the cotton. — Also employed in the **Printing** of **silk,** also **silk-cotton unions.**
New Methylene Grey G. powder.  Methylene Grey ND. powder. 	In **Cotton-dyeing** used alone or along with other basic dyestuffs for the production of grey shades on loose cotton-wool, yarn and piece-goods of all kinds; the dyes are satisfactorily fast to light, washing, and acid. — In the **dyeing** of **wool-cotton,** and **silk-cotton unions** it is used for shading the cotton. In **Calico-printing** largely employed, chiefly as a self-colour, more rarely for compound shades. — In **printing silk** and **silk-cotton unions,** as well as **wool** and **wool-cotton unions.** — In the **dyeing** of **Leather, Paper, Buttons** of **horn** or **vegetable ivory,** and **Feathers.** — In the manufacture of **Writing** and **Marking-Inks.**
Methylene Green extra yellow conc. patented. 	In **Cotton-dyeing** as the fastest basic Green dyestuff on tannin and tartar-emetic mordant, used on loose cotton-wool, yarn, and piece-goods, also for shading other basic and alizarin dyes. — On **Silk** only used for topping logwood blacks. — In **Calico-printing** employed as a steam-tannin-colour and for dyeing on tannin and tartar-emetic mordant, also for shading steam-alizarin-colours. — In **printing silk-cotton** and **wool-cotton unions** also **silk.** — In **Leather-dyeing,** and for the production of fast **Green Lakes** for lithographic printing.

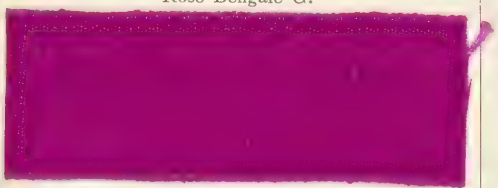
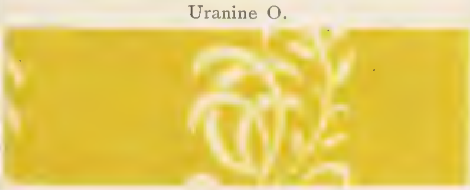
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Brilliant Green (Cryst. extra, cryst. extra N, Powder superior, Ia, No. 12) **Malachite Green** (Cryst. extra, Powder B, BB, 4 B, superior, Ia., No. 12)	1877/78	Add acetic acid to the colour and dissolve in boiling water, filtering the solution before use; or, the colour is made into paste with glycerine and alcohol.	Dye in a slightly acid bath, or better still on wool mordanted with sulphur by boiling it with a solution containing 15% thiosulphate of soda (hyposulphite), 5% alum and 3% sulphuric acid. On sulphur mordant the colour is much faster to washing and to light.	Dye on tannin and tartar-emetic mordant, dark shades on tannin and iron mordant; also used for topping and shading wood colours and direct-dyes.	Dye at 70°—80° C. (160°—175° F.) in a bath containing boiled-off liquor, and made neutral or slightly alkaline, but not acid; brighten with acetic acid.
New Green (O 20% paste, and O powder)	1886	Dissolve on the water-bath in its own weight of ethyl-tartaric acid and acetic acid, continue heating until thoroughly dissolved.		Employed only in calico-printing, by printing a mixture of the colour solution and acetic acid and tannin thickening, then steaming and fixing in tartar-emetic bath.	

Colours.

Employment	Dyed Patterns
In **Wool-dyeing** still used because of its cheapness, for hosiery and embroidery yarns, either alone or along with basic violet for producing green and blue shades. — In **Cotton-dyeing** used by itself on tannin and tartar-emetic or iron mordant; along with Methyl Violet for shading other basic-dyes; further for topping wood-colours and direct-dyes. — In **Silk-dyeing** much used either alone or in combination with numerous other dyestuffs, both on yarn and cloth. — In dyeing **Unions** of **silk-cotton, wool-cotton** and **silk-wool,** used for shading the cotton, also for the production of shot effects as well as for dyeing solid shades. — In **Calico-printing** chiefly used for mixing with and shading other basic dyestuffs in steam-tannin-colours. In **printing wool, silk, wool-cotton,** and **silk-cotton unions,** used mostly as a tannin-colour. — In **Leather** and **Skin-dyeing** used alone and in mixtures. — On **Jute, Cocoa-nut fibre, Straw, Feathers,** and **Artificial Flowers,** used alone and mixed with numerous other dye-stuffs. — In **Paper-dyeing** very largely used both alone and in combination, for colouring paper-pulp, dipping, and paper-staining for fancy coloured papers. — In the manufacture of **Colour-lakes** very largely used both alone and in combination, being precipitated by tannin, soap, or resin; also for shading dye-wood lakes, and barium and lead lakes of Acid Colours; also for **Lime-green,** and for dyeing and brightening ochres. — For **Hectograph Inks** in combination with Magenta or Methyl Violet; for colouring **Spirit Varnishes,** also for **Candles** in the form of oleates or resinates of the colour-base.	Brilliant Green Crystals extra.  Malachite Green Crystals extra.  Brilliant Green Powder superfine.  Malachite Green Crystals extra. 
In **Calico-printing** chiefly as a self-colour, occasionally in mixtures as a steam-tannin-colour. These colours are noteworthy for their yellowish shade, their marked fastness to light, and their satisfactory fastness to washing.	New Green O powder. 

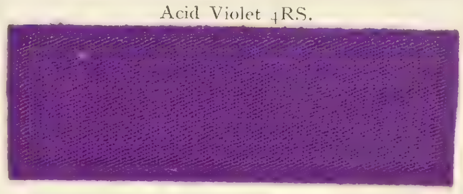
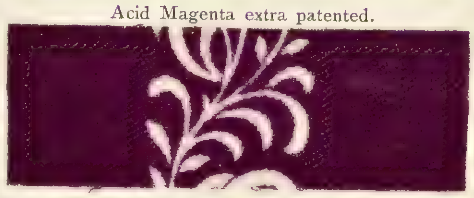
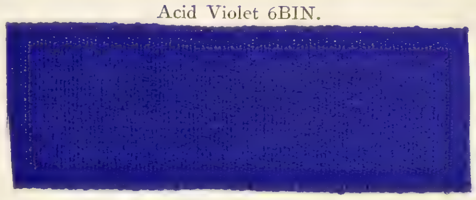
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Eosine (extra, extra yellow shade, yellow shade, extra conc., extra BB, 3B, BA, A conc., 2A, AG—A6G, S, etc.) extra soluble in spirit. **Erythrosine** (A, AG, blue shade, yellow shade, extra, etc.) **Phloxine** (O, G, B, BB, 5B, BA, extra, etc.) **Rose Bengale** 3B conc., B, G, etc.) **Cyanosine** spirit **Bromo-fluoresceïne** (crystals, B)	1874	Dissolve in hot water; avoid the use of acids altogether. The brands which are soluble in spirit are dissolved in methylated spirit. The bromo-fluoresceïnes are dissolved in water with the addition of 20% Solvay-soda.	Boil the wool with a solution of 5% alum, 5% cream of tartar, and 5% acetic acid, and dye in the same bath; or dye with the addition of 10% acetic acid, entering lukewarm and raising gradually to the boil.	1. Add the colour solution to a bath of common salt at 5°—7° Tw., and dye at a tepid heat, take out and dry. 2. Dye on cotton mordanted as for Turkey-red, at 40°—50° C. (105°—120° F.). 3. 1st bath: Stannate of soda. 2nd bath: Basic alum solution. 3rd bath: Dye at 40°—50° C. (105°—120° F.) After all three processes dry without washing.	Dye just below the boil in a bath containing boiled-off liquor and acidified with acetic or tartaric acid; brighten with acetic or tartaric acid.
Roseline (B, G, R and conc. w.)	1892	The powder-colours are dissolved in hot water free from lime; the paste-colours are simply mixed with water.		In Calico-printing used as a steam-chrome-colour.	Dye just below the boil in a bath containing boiled-off liquor and acidified with acetic acid; brighten with acetic or tartaric acid.
Uranine (O)	1874	Dissolve in hot water; avoid the use of acids.	Boil the wool in a solution of 5% alum, 5% cream of tartar, and 5% acetic acid, and dye in the same bath; or dye in a bath containing 10% acetic acid and colouring matter, entering lukewarm and raising the temperature gradually to the boil.	In Calico-printing used as a steam-chrome-colour.	Dye in a bath containing boiled-off liquor acidified with acetic or tartaric acid; brighten with acetic or tartaric acid.

Colours.

Dyed Patterns	Employment
Eosine extra.  Erythrosine yellow shade.  Rose Bengale G.  Phloxine O. 	In **Cotton-dyeing** used as self-colours of exceptional brilliancy, on yarn and piece-goods, whenever fastness is not required. In **Wool-dyeing** for very bright pinks, especially on zephyr and fancy yarns, as well as on light piece-goods for export. — In **Silk-dyeing** very largely employed for bright fluorescent self-colours in all shades of pink from the yellowest to the bluest hues. — In **Calico-printing** as a fast steam-chrome-colour, also as an albumen colour. — In **printing wool, silk,** also **silk-cotton** and **wool-cotton unions,** chiefly used as a self-colour. — In **Leather-dyeing.** — In **Dyeing** and **Printing Jute.** — In dyeing **Feathers, Artificial Flowers, Straw, Cocoanut-fibre.** — Very largely used in the manufacture of Paper, for colouring paper-pulp, dipping and paper-tainings. — In the manufacture of **Colour-lakes,** the yellow brands are largely used as lead compounds along with red-lead to imitate vermilion; further, all brands are used as lead-lakes on different bases for producing geranium, carmine, and anticarmine colours, for fancy papers, paper-hangings, water-colours, and lithographic colours. — In the manufacture of **Inks** for **writing,** ruling and marking. — For the manufacture of brilliantly coloured **Spirit Varnishes** (for which purpose the brands soluble in spirit are used); for colouring **Soap,** articles of **Perfumery** and **Food-stuffs.**
Roseline B conc. w. 	For **dyeing** used only on **Silk,** chiefly on yarn, as a self-colour for pink and red. — In **Calico-printing** as a steam-chrome-colour used either alone or in combination with Eosine and Alizarin colours; also for padding pink. — For **printing Silk** and **Silk-cotton Unions** in the piece. — **In Paper-dyeing.**
Uranine O. 	Seldom used for dyeing, chiefly for **printing wool, silk** and **cotton.** — Seldom used in the manufacture of **Colour-Lakes,** but occasionally for colouring **Paper,** and **Spirit Varnishes.** — For colouring **Food-stuffs.**

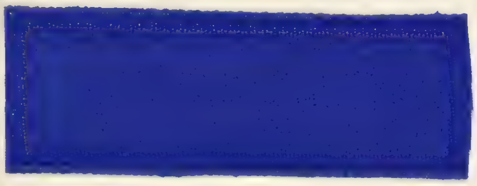
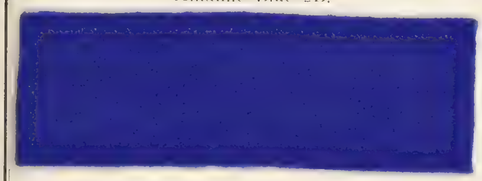
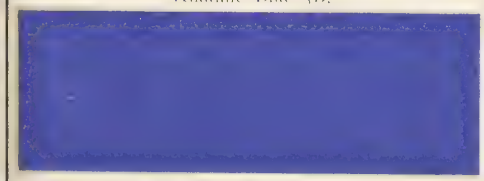
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Acid Magenta (O, B, D, G, GG, 3B extra, extra B) patented **Acid Cerise** (O, II) **Acid Maroon** (O) **Maroon** (S) **Orseilline** (R, B) **Acid Violet** (4RS, 3RS, 3RA, II, R conc.)	1877	Dissolve in boiling water.	Dye at the boil in an acid bath, with addition of 4% sulphuric acid and 10% Glauber's salt, or 10% bisulphate of soda. Tends to dye level on boiling, hence canbe added in small portions even to the boiling bath.		Dye just below the boil in an acid bath containing boiled-off liquor, or also in an acid bath in the same manner as wool. Brighten with sulphuric acid.
Acid Violet (N, 5BF, 5BFI, 6BF, 6BIN, 7BN)	1886/87	Dissolve perfectly in boiling water, but on no account in the acid dye-bath.	Dye at the boil in an acid bath, with addition of 4% sulphuric acid and 10% Glauber's salt, or 10% bisulphate of soda. May be added to the boiling dye-bath, but only if in perfect solution. — Used also in logwood dyebath, and in single-bath along with logwood extract, copper and iron sulphate, and oxalic acid. Fast to milling if saddened with 4% sulphuric acid and 10% chrome alum or with 4% fluoride of chromium.		Dye just below the boil in an acid bath containing boiled-off liquor. Brighten with sulphuric acid.

Colours.

Employment	Dyed Patterns
In **Wool-dyeing** on all kinds of yarn and piece-goods, where fastness is not required, occasionally used as a self-colour, but chiefly in combination with other acid-dyestuffs for the production of red, bordeaux, garnet, maroon, otter and brown, also blue, sea-green, and Russian green. — In **Silk-dyeing** used for **silk-cotton unions.** — In **printing wool** and **silk,** also **wool-cotton** and **silk-cotton unions.** — In **Leather-dyeing** and the manufacture of coloured **Paper** and **Colour-Lakes,** finds a limited use.	Acid Violet 4RS.  Acid Magenta extra patented. 
In **Wool-dyeing** occasionally on **loose-wool,** either alone or in combination with logwood; much used on **yarns** particularly on weft-yarn intended for milled goods, in combination with logwood; on **hosiery** and **zephyr yarns** in combination with other acid-dyestuffs; on **slubbing** along with other acid-colours and with Chromotrope S for navy-blues, to be milled in water only; on **Piece-goods,** especially light woollens and worsteds in combination with other acid-colours, and on cheap dress-goods with logwood extract. — In **Silk-dyeing** on yarn and piece-goods, and for silk-cotton unions; also for solid dyeing of **silk-wool unions** and in **Garment-dyeing.** — In **Wool, Silk,** and **Melange** (slubbing) printing. — In dyeing **Jute, Cocoanut-fibre, Straw, Artificial Flowers** and **Feathers.** The mark 5BF is specially useful for **shoddy** and **shoddy materials.** — Acid Violet is also used in **Leather-dyeing,** and in the manufacture of **Coloured Paper** and **Colour-Lakes.**	Acid Violet 5BF.  Acid Violet 6BIN.  Acid Violet N. 

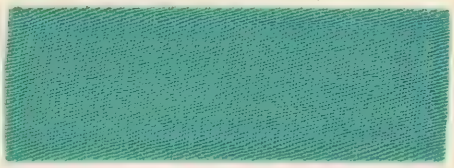
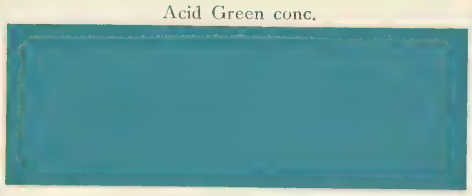
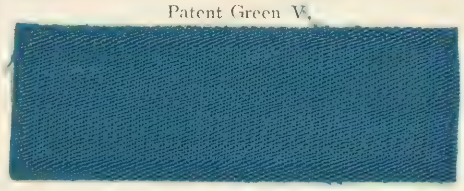
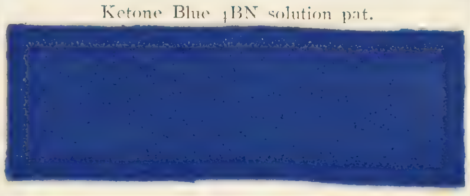
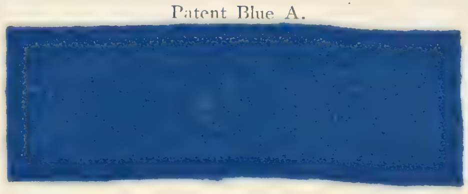
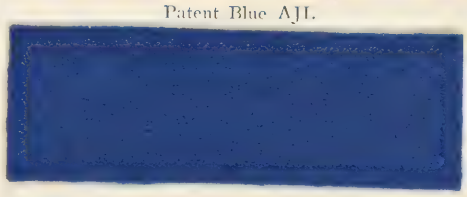
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Conc. Cotton Blue (2R, R, No. 1, 2, 3, 4) **Pure Blue** (O, conc., double conc.) **Cotton Blue** (extra, OO) **Methyl Blue for Cotton** (MLB) **China Blue** (R, No. 1, 2) **Soluble Blue** (3R, 2R, R, SV) **Bleu de Lyon** (RR, R, O) **Opal Blue** (red shade, blue shade, green shade) **Laundry Blue** (O) **Purple Blue** (O) **Cloth Blue** (O) **Full Blue** (O) **Body Blue** (O) **Navy Blue** (V) **Blue** (red shade, blue shade) **Opal Blue** (superfine, soluble) **Paper Blue** **Blue for Silk** (T, green shade, T conc., KR) **Methyl Blue for Silk** (MLB)	1862	Dissolve thoroughly in boiling water; avoid any addition of acid.	1. Dye with the addition of 10% Glauber's salt and 2% sulphuric acid, or with the addition of 5% alum; enter at 40° to 50° C. (105°—120° F.), raise to boil and continue boiling 1 hour. 2. For logwood colours add the colour to the alum and bichrome mordant bath, or dye in single-bath with colour, oxalic acid, sulphate of iron and copper, and logwood extract. 3. For topping and shading logwood colours.	1. Mordant with tannin and tartar-emetic and dye with addition of 10% alum to the bath. 2. Mordant with soap and stannic chloride, and dye with the addition of alum. 3. Dye with colouring matter and stannate of soda, then gradually add sulphuric acid to the bath.	Dye in bath containing boiled-off liquor acidified with sulphuric acid, enter at a low temperature and raise slowly to the boil. Brighten with sulphuric acid. — After-treatment with a solution of sumach or gallnut extract renders the dye fast to washing.
Alkaline Blue (7B, 6B, 5B, 4B, 3B, 2B, BBR, B, R, R conc.) **Alkaline Violet** (O) **Methyl Alkaline Blue** (MLB)	1862	Dissolve thoroughly in boiling water; avoid carefully any addition of acid.	Boil first with colour solution and 4—10% borax (carbonate and silicate of soda are not so good); then develop in fresh bath at 60°-70° C. (140°-160° F.) with 5% sulphuric acid; for colours faster to milling develop with alum or stannic chloride solutions.		Dye just below the boil with addition of 6% Marseilles soap, and then develop in fresh bath with sulphuric acid. Brighten with sulphuric acid.

Colours.

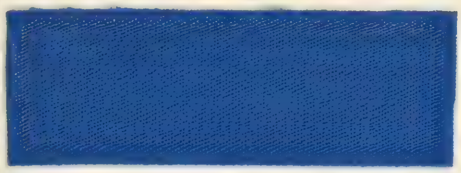
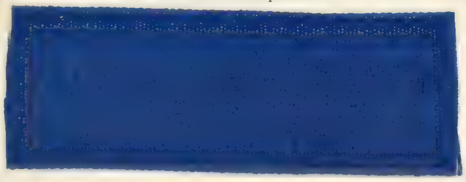
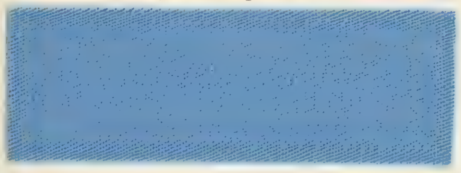
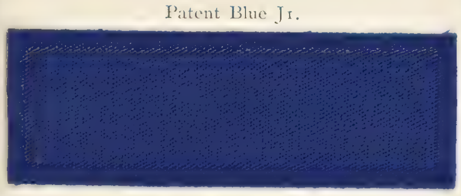
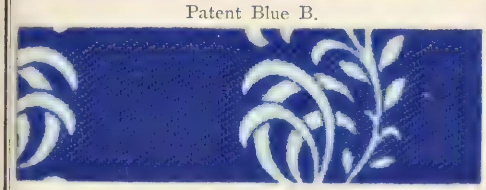
Dyed Patterns	Employment
Opal Blue, blue shade.  Methyl Blue for silk MLB.  Pure Blue O.  Bleu de Lyon R. 	In **Wool-dyeing**, on **loose-wool** limited to employment in combination with logwood, more used for **shoddy**; on **yarn** used along with logwood; largely used for **piece-goods,** usually alone on **shoddy-cloth,** and on heavy **dress-goods** used for grounding, blooming, or topping, in combination with logwood or woaded logwood colours, in the production of imitation indigo blues. — In **Silk-dyeing** much used as a grounding for all shades of blue. — In **Cotton-dyeing** used for yarn and piece-goods, where fastness to washing is not required. — In **dyeing wool-cotton, silk-cotton** and **silk-wool unions.** — Much used for **printing wool, silk, silk-cotton** and **wool-cotton unions.** — In **Calico-printing** finds limited use as a chrome-lake, and for brightening or substituting ultramarine blue. — In **Paper-manufacture** used very largely for colouring paper-pulp and for staining. — In dyeing **Jute, Cocoanut-fibre, Straw, Feathers** and **Artificial Flowers.** — In the manufacture of **Colour-lakes** very largely employed for making ultramarine substitutes. — Used also in the manufacture of ruling, writing, and marking **inks,** and for brightening ordinary logwood and gall-nut inks.
Alkaline Blue 2B.  Methyl Alkaline Blue MLB.  Alkaline Blue 5B. 	For **Wool,** on **yarns** of all kinds, also on **piece-goods,** especially on thin woollens and worsteds as a brilliant self-colour, less frequently as a grounding for compound shades. — In **Silk-dyeing** very largely used, chiefly for grounding and also blooming **blacks** and very **dark blues,** occasionally as a self-colour. — For **dyeing silk-cotton, wool-cotton,** and **silk-wool unions.** — In **Calico-printing** chiefly used as a chromium-Turkey-red-oil-lake. — In **printing-silk, wool, silk-cotton** and **wool-cotton unions.** — For dyeing and printing **Jute.** — In **Paper-colouring.** — In **Leather-dyeing.** — In dyeing **Straw, Cocoanut-fibre, Feathers.** — In the manufacture of **Colour-lakes** as a substitute for ultramarine, being precipitated on a barytes base or better still as a chromium-Turkey-red-oil-lake.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Acid Green (O, D, G, M, conc., conc. D, conc. G, conc. M, II, Solution conc. M, 5 fold conc.)	1878/79	Dissolve in boiling water.	Dye at the boil in an acid bath with addition of 4% sulphuric acid and 10% Glauber's salt or 10% Bisulphate of soda. Dyes level in fresh baths with some difficulty, but satisfactorily in old baths.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.
Patent Green (O, V) **Patent Blue** (VVS, VG)	1893/94	Dissolve in boiling water.	Dye at the boil in an acid bath with the addition of 4% sulphuric acid and 10% Glauber's salt or 10% Bisulphate of soda. Dyes level and can even be added in small quantities to the boiling bath.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with acetic acid.
Ketone Blue (4BN solution) patented	1893	Can be added direct to the dye-bath.	Dye at the boil in an acid bath with addition of 4% sulphuric acid and 10% Glauber's salt or 10% Bisulphate of soda.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.
Patent Blue (A, AJ1)	1890	Dissolve in boiling water, but on no account in the acid dye-bath.	Dye in an acid bath with the addition of 4% sulphuric acid and 10% Glauber's salt or 10% Bisulphate of soda, or better still boil first with the addition of 10% Glauber's salt only and add afterwards 4% sulphuric acid. Dye also with addition of 10% acetic acid on unmordanted or chrome-mordanted wool.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.

Colours.

Employment	Dyed Patterns
On **Wool** largely employed, on **yarns** and thin or low class **piece-goods** chiefly used in combination with other dyestuffs for producing the most varied shades of blue and green, but in all cases only when fastness to washing and to alkali is not required. — In **Silk-dyeing** chiefly used along with other acid colours for producing compound shades. — In **printing wool** and **silk.** — In dyeing **wool-cotton** and **silk-cotton unions** for plain colours and shots. — In **Paper-dyeing** for colouring paper-pulp and for staining. — In **Leather-dyeing** also in the dyeing and printing of **Jute.** — In the manufacture of **Colour-lakes** used on a barytes or lead base, either alone for producing various shades of green, or in combination with other acid colours. — In the manufacture of **Inks** used alone and also for shading or brightening ordinary gall-nut or logwood inks.	Acid Green conc. D.  Acid Green conc. 
On **Wool** chiefly in **piece-dyeing** for navy-blue, green, olive and brown, but also for fancy shades in combination with Azo Acid Magenta, Chromotrope 6B and 2R, and Victoria Violet 4BS. — The shades thus produced far excel in fastness those obtained with Acid Green or Indigo Carmine, and are much cheaper than Indigo Carmine shades. — In combination with Chromotrope FB and Chrome Brown RO and BO used also for the production of fast and cheap dark blues and browns on heavy piece-goods.	Patent Green V. 
On **Wool** for **Slubbing** and **Yarn** used as a fast substitute for Indigo-carmine for blues and fancy colours intended for milling with water only; on **Knitting Yarn** and also in **Piece-dyeing** for navy-blue, in combination with Azo Acid Magenta and Chromotrope 6B in acid bath; with Chromotrope FB developed subsequently with bichrome for very fast dark indigo blue shades, especially on heavy cheviots and worsteds; further for all kinds of fancy shades. — On **Silk** as a self-colour and also in combination with other acid-colours. — In **Wool-printing** for covers, details and outlines, and also as a tin-crystal discharge colour on dyed Azo colours; also in **Tapestry, Carpet-yarn printing, Melange-printing** and **Silk-printing.** — In **Paper-dyeing.** — In the manufacture of **Colour-lakes** for the production of very brilliant colours on a barytes base. — In the manufacture of **Ink** used either alone or in combination with gall-nut or logwood inks.	Ketone Blue 4BN solution pat.  Ketone Blue 4BN solution pat. 
In **Wool-dyeing** on **loose-wool** for bright colours in acetic acid bath along with other acid-colours, with Chromogen I for single bath fancy colours, for topping and brightening alizarin-colours, on **Slubbing** employed in the same manner. — On **Yarn** specially suitable for weft-yarn also for heavy milling, as well as for yarn which has to be milled with water or soap. — On **Shoddy.** — In **Piece-dyeing** not much used being less fast to rubbing than Patent Blue V and Ketone Blue which are preferred. — In **Melange-printing** largely employed either alone or in combination with other colours. — In **Leather-dyeing,** also for dyeing **Jute, Cocoa-nut fibre, Straw.** — In **Paper-dyeing** for colouring paper-pulp, also for dipping and staining. — In the manufacture of **Colour-lakes** precipitated on a barytes or lead base, either alone or in combination with other colours.	Patent Blue A.  Patent Blue AJL. 

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Patent Blue (V, superfine, N, G conc.) **Cyanine** (B) patented	1888	Dissolve in boiling water, or also in the acid dye-bath itself.	Dye in an acid bath with the addition of 4% Sulphuric acid and 10% Glauber's salt, or 10% Bisulphate of soda; it dyes perfectly level and can be added to the boiling bath even in the smallest portions. Dye also with the addition of 10% acetic acid for topping alizarin-colours.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with acetic or tartaric acid.
Patent Blue (B, J1, J2, J3, Jo, Joo) **Indigo substitute** (B, BS) patented	1888	Dissolve in boiling water, but on no account in the acid dye-bath. When perfectly dissolved add to the dye-bath through a sieve or flannel filter.	Dye in an acid bath with addition of 4% sulphuric acid and 10% Glauber's salt, or 10% Bisulphate of soda. Dyes very level even when the smallest additions are made to the boiling bath.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with acetic or tartaric acid.

Dyed Patterns	Employment
Patent Blue V.  Patent Blue superfine.  Patent Blue N.  Cyanine B patented. 	In **Wool-dyeing** of immense importance, because it is the fastest level-dyeing blue acid-colour; on **loose-wool** only used in small quantity for shading alizarin-colours, on **Slubbing** its use is also chiefly confined to the brightening of alizarin and chrome developed colours. — In **Yarn-dyeing** largely employed as the best available substitute for Indigo-carmine, which it surpasses in fastness to washing, alkali, and light, and also as regards cost; used for stocking, knitting, zephyr, fancy, carpet, and weft yarns. — In **Lace-dyeing.** — In **Piece-dyeing** used very largely on all materials as the fastest blue for sea-green and Russian green, also for all kinds of compound and fancy shades in combination with acid and chrome developed colours. — In **Silk-dyeing,** especially the mark «superfine», used as a brilliant self-colour. — For dyeing wool-cotton and silk-wool unions, shoddy cloth, woollen cloth with cotton effects, and wool plush. — For **printing wool** and **silk material, woollen yarn,** and **slubbing.** — In **Leather-dyeing.** — For dyeing and printing **Jute.** — In **Paper-dyeing** used for dipping and staining. in the production of fancy coloured papers. In the manufacture of **Colour-lakes** as a barium or lead precipitate on an alumina base, for imitations of ultramarine and blue verditer. — In the manufacture of **Ink,** also for colouring **Feathers** and **Artificial Flowers.**
Patent Blue Jr.  Patent Blue B. 	In **Wool-dyeing** largely used, especially for knitting and stocking yarns, also for weft yarns, mohair, zephyr, carpet, and fancy yarns; in **Piece-dyeing** also largely employed for all compound and fancy colours as the best and fastest substitute for indigo-carmine, since it is much cheaper and faster. — In **Silk-dyeing** used only to a limited extent. — In dyeing **wool-cotton** and **silk-wool unions** also for **shoddy** materials. — In **Wool-printing.** — In **Leather-dyeing.** — In the dyeing and printing of **Jute.** — In **Paper-dyeing.**

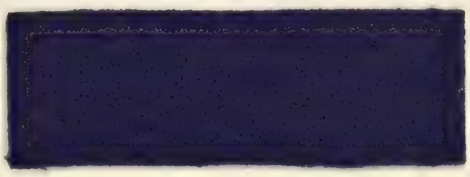
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Fastblue (O, R, RR, 3R extra, 5R extra, 5R No. 60, D, G extra, 5B, green shade, extra greenish, RD, RRD, RAD) **Induline** (2N, 2N greenish) **Blackblue** (O) **Black Black** (O) **Coupier's Blue** **Nigrosine** (Grey Blue No. I,II,III,IV)	1867	Dissolve in boiling water, but on no account in the acid dye-bath.	1. Dye at the boil with addition of the dyestuff, acetate, oxalate, or sulphate of ammonia, and add gradually to the same bath acetic or oxalic acid, or develop in a separate bath with sulphuric acid. 2. Dye at the boil in a neutral bath with addition of the dyestuff, acetate of soda or acetate of ammonia, and then add gradually sulphuric acid. 3. Used in the mordant-bath for grounding logwood colours, or in single-bath along with oxalic acid, sulphate of copper and iron, and logwood extract.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.
Wool grey (R, B, B double, G) patented	1889	Dissolve in boiling water, but not in the acid dye-bath.	Dye at the boil with the addition of 4°/₀ sulphuric acid and 10°/₀ Glauber's salt, or 10°/₀ Bisulphate of soda; very small additions of colour solution may be made to the boiling bath if necessary.		
Fast Acid Blue (R, R conc.) patented **Violamine** (3B) patented	1892/93	Dissolve in boiling water, not in the acid bath.	1. With addition of 3°/₀ sulphuric acid and 10°/₀ Glauber's salt, or 15°/₀ Bisulphate of soda; enter at 50°–60° C. (120°–140° F.), raise to the boil, and boil 1 hour. 2. Dye at the boil with addition of 10°/₀ Glauber's salt and 10°/₀ Acetic acid. 3. Boil with addition of 10°/₀ Glauber's salt, adding gradually 4°/₀ sulphuric acid. 4. For topping alizarin-colours.		Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.

Colours.

Employment	Dyed Patterns

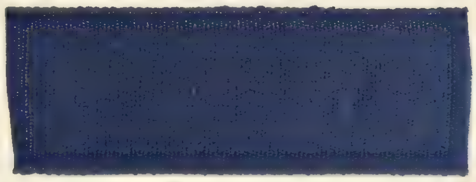
In **Wool-dyeing** on **loose-wool** alone and in combination with logwood for blues not required to be specially fast chiefly for the under warp or weft of double-cloths. — For **shoddy.** — Much employed in **Yarn-dyeing** for knitting and vicuna yarns, also for carded and combed yarns for medium and light milling. — Much used also in **Piece-dyeing** for cheap dress-goods, shoddy-cloth, also for wool-cotton and silk-cotton unions. — Employed also for plain colours on **silk-wool unions.** — Piece-goods must always be washed with fuller's earth. — In **wool-printing** largely used for **piece-goods, yarn,** and **slubbing.** — Used also in **silk-printing,** as well as in the printing of wool-cotton and silk-cotton unions. — In the dyeing and printing of **Jute.** — In **Leather-dyeing.** — In **Silk-dyeing** used in considerable amount for dark-blues, black-blues, grey-blues and slate colours both on yarn and pieces. — In **Paper-dyeing** much used for colouring paper-pulp and for staining. — In the manufacture of **colour-lakes** employed as a barium lake chiefly for shading and darkening other acid-colours. — In the manufacture of **Ink** used alone and for shading gall-nut and iron ink.

Fastblue soluble.



Fastblue RAD.

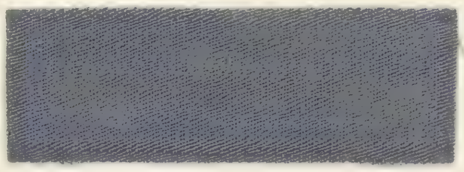
Nigrosine No. 1.



Blackblue O.

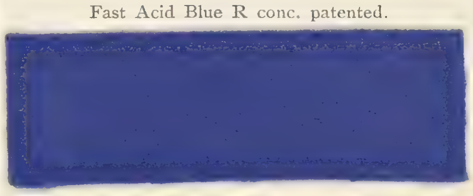
In **Wool-dyeing** occasionally used for yarn, but more frequently in the **Piece-dyeing** of thin woollen and worsted materials both as a self-colour and shaded with other level-dyeing acid-colours. — In **Wool-printing** chiefly used as a self-colour. — Employed also for dyeing cotton-warp cashmeres and zanellas. — In **Paper-dyeing.**

Woolgrey G patented.

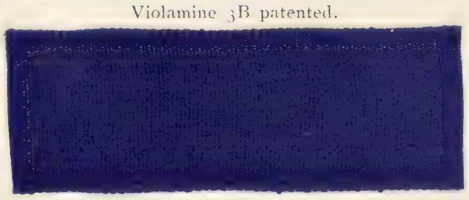


In **Wool-dyeing** used on **loose-wool** for **white, pearl-grey,** and **light blue** colours to stand milling; on **slubbing** used both alone and in combination for colours required to be fast to milling, water, and light. — Used on **woollen** and **worsted yarns** as well as on **knitting** and **stocking yarns** for single-bath shades fast to milling, water, and light, also for topping alizarin-colours or for shading them towards the end of the dyeing operation. — Seldom used on **piece-goods.** — In **Silk-dyeing** used as a fast blue, and particularly also on silk weighted with tin. — In **Wool-printing** very important for **melange** printing.

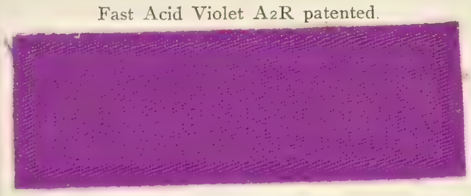
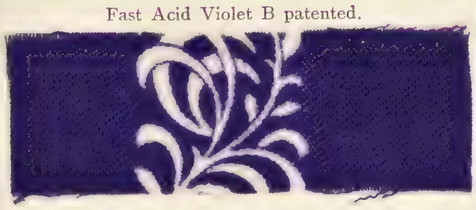
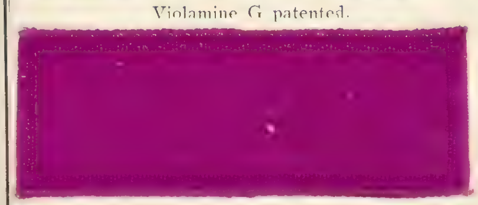
Fast Acid Blue R conc. patented.



Violamine 3B patented.



Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Fast Acid Violet (A 2 R, R, B) patented **Violamine** (G, A2R, R, B) patented **Acid Rosamine** (A) patented **Fast Acid Red** (A) patented	1889	Dissolve in boiling water, but avoid adding the colour direct to the acid dye-bath.	Dye in acid bath with the addition of 10% Glauber's salt and 4% sulphuric acid, or 10% bisulphate of soda. — Also with the addition of acetic acid for topping alizarin-colours.	Used only in calico-printing as a steam-chrome-colour	Dye just below the boil in an acid bath containing boiled-off liquor; brighten with sulphuric acid.

Dyed Patterns	Employment
Fast Acid Violet A2R patented.  Fast Acid Violet B patented.  Violamine G patented. 	In **Wool-dyeing** used on **loose-wool** for pale shades as a particularly level-dyeing fast acid-red, also in combination with Chromogen I in single-bath, further as a fast topping or grounding colour for vat-blue. — On **slubbing** for colours fast to water and milling, also for shading and using in combination with other colours also as a self-colour. — In **Yarn-dyeing** for colours fast to light and water, and in pale shades for such as are also fast to milling whether dyed in acid bath or on chromed material, also for shading alizarin-colours. — In **Piece-dyeing** as a level-dyeing red colour for all kinds of fancy colours and dark compound shades, since it is perfectly fast to alkali and satisfactorily so towards light. For dyeing plain colours on **silk-wool unions** and in **garment-dyeing**. — On **Silk** used for yarn and piece-goods as a very fast self-colour and for compound shades which are specially fast to light, and very suitable also on silk weighted with tin. — In **Wool-printing** used both on piece-goods and yarn, very largely also in **melange-printing**. — For dyeing **Paper-pulp**, especially for colours fast to light. — In **Calico-printing** as a steam-chrome-colour for shading alizarin.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Naphthol Yellow (S, SE)	1879/80	Dissolve in boiling water.	Dye at the boil in acid bath with addition of 10% Glauber's salt and 4% sulphuric acid, or 10% bisulphate of soda. — Dyes very level, so that small additions may be made to the bath even at the boil.		Dye in an acid bath containing boiled-off liquor; brighten with sulphuric acid.
Azo Yellow (conc. O,R)	1880	Dissolve in boiling water, but not in the acid bath.	Dye at the boil in acid bath with the addition of 10% Glauber's salt and 4% sulphuric acid, or 10% bisulphate of soda. — Dyes very level, so that small additions may be made to the bath even at the boil.		Dye in an acid bath containing boiled-off liquor; brighten with sulphuric or acetic acid.
Victoria Yellow (O, double, conc.) **Orange** (No. 4, 4LL) **Acid Yellow** (cryst.)	1879 1876/77	Dissolve in boiling water, but not in the acid dye-bath.	Dye at the boil in acid bath with the addition of 10% Glauber's salt and 4% sulphuric acid, or 10% bisulphate of soda. Dyes very level, so that small additions of colour may even be made to the boiling dye-bath. — Excess of acid must be avoided, because this would make the shade redder.		Dye in an acid bath containing boiled-off liquor; brighten with acetic acid or with a little sulphuric acid.

Azo Colours.

Employment	Dyed Patterns
On **Wool** both for yarns of all kinds and for light piece-goods, very largely employed for all varieties of shades as a level-dyeing and very pure yellow, chiefly for compound shades. — On **Silk** also largely used, especially for bright compound colours. — Very useful for woollen goods with cotton and silk effects, because in acid bath the wool only is dyed. — In **wool** and **silk-printing** used on a large scale. — In **Leather-dyeing**, also in dyeing **Jute, Straw,** and **Cocoa-nut fibre**. — Very much used also in **Paper-dyeing** both alone and in combination with other colours for colouring paper-pulp and also for staining in the production of fancy coloured papers. — In the manufacture of **Colour-lakes** precipitated as a barium lake on an alumina base for pure yellow and green lakes for coloured papers and wall-papers.	Naphthol Yellow S. Naphthol Yellow S.
On **Wool** both for **yarn** and **piece-goods,** also for heavy dress-goods it is used for shading compound and fancy colours. — Remarkable for its fastness to alkali, also fast to acid. — In **Silk-dyeing** very much used for yarn and piece-goods as a very fast yellow, chiefly for compound shades and as a ground-colour. - On **wool-cotton** and **silk-cotton unions** for dyeing the animal fibre only, much used also for **silk-wool unions** and in **garment-dyeing**, because it dyes the silk and wool equally. — In **wool** and **silk printing** chiefly used for compound colours. — In **Leather-dyeing,** also in dyeing **Straw, Jute, Cocoa-nut fibre,** and in the **manufacture of paper** for colouring paper-pulp and for staining. — In the manufacture of **Colour-lakes** precipitated with barium and used in combination with other colours, used also in the manufacture of **soap.**	Azo Yellow conc. Azo Yellow conc.
On **Wool,** both **yarn** and **piece-goods,** used on a very large scale, Victoria Yellow chiefly for fancy colours, Orange No. 4 as a very cheap colour for dark shades such as brown, olive, bronze etc., very fast to alkali and fairly fast to light. — In **Silk-dyeing** much used for full yellow compound colours on yarn and piece-goods. — Also used in **wool** and **silk-printing** especially for compound colours; also for **Jute, Straw,** and **Cocoa-nut fibre.** — Used in **Leather-dyeing,** also very largely in **Paper-dyeing,** particularly for colouring paper-pulp for producing compound shades, but largely also for staining coloured papers. — In the manufacture of **Colour-lakes** it is precipitated as a barium lake, — the pure concentrated marks are also used for the manufacture of **Spirit-varnishes.** — Also used for colouring **Soap.**	Orange No. 4. Victoria Yellow O.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Orange (G, No. 2, O, No. 1, R, RR, No. 64) **Brilliant Orange** (G, O, R)	1877/78	Dissolve in boiling water.	Dye in acid bath with addition of 10% Glauber's salt and 4% sulphuric acid, or 10% bisulphate of soda. — Dyes very level, so that additions of colour may be made even to the boiling bath for shading.	Dye at a tepid heat in a strong bath of common salt at 6° Tw., or mordant with basic-alum solution and dye in a fresh bath. — Or, prepare with stannate of soda, then mordant with basic-alum solution and dye.	Dye at the boil in an acid bath with the addition of boiled-off liquor; brighten with sulphuric or acetic acid.
Scarlet (GG, G, GL, GV, GRII, R, RVL, RL, RR, 3R, 3RL, 4R) **Brilliant Lake Scarlet** (G, R, 2R)	1879	Dissolve in boiling water; it is best to make a paste by adding at first only a little water, and then to add a large quantity of boiling water, with constant stirring.	Dye in acid bath with addition of 10% Glauber's salt and 4% sulphuric acid; enter at 50°—60° C. (120°—140° F.), raise to the boil and boil ³/₄—1 hr. — The colour is rapidly attracted by the fibre and therefore does not readily dye level, hence with goods which are difficult to dye through add 4% hydrochloric acid and 10% Glauber's salt, or 3% sulphuric acid and a large amount (100%) of Glauber's salt.	1. Dye at a tepid heat in a strong bath of common salt at 6° Tw. 2. Mordant with basic-alum solution, and dye in a fresh bath. 3. I. Bath: Stannate of soda. II. Bath: Basic-alum solution. III. Bath: Dye.	Dye in an acid bath containing boiled-off liquor; enter at 50° — 60° C. (120°—140° F.) and raise to the boil. Brighten with sulphuric acid.
New Coccin (O) **Victoria Scarlet** (G, R, 2R, 3R, 4R, 5R, 6R) **Crystal Scarlet** (6 R) **Scarlet** (6R) patented	1878	Dissolve in boiling water.	Dye in acid bath with addition of 10% Glauber's salt and 3% sulphuric acid; enter at 50°—60° C. (120°—140° F.) raise to the boil and boil ³/₄—1 hr; a little more difficult to dye level than the Scarlets, hence it is desirable to use as little acid as possible consistent with development of the colour, or to use hydrochloric instead of sulphuric acid.		Dye in an acid bath containing boiled-off liquor; enter at 50°—60° C. (120°—140° F.) and raise to the boil. Brighten with sulphuric acid.

Azo Colours.

Dyed Patterns	Employment

Orange G.

Orange No. 2.

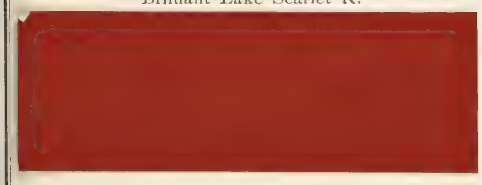
Brilliant Orange G.

On **Cotton** employed for yarn and piece-goods, when fastness to light is desired, but not fastness to water and washing. — On **Wool** for weft, knitting, fancy, and carpet-yarns, also for all kinds of piece-goods, most extensively used for fancy shades (especially Orange G since it is the fastest), and for compound shades of all kinds. — Orange G is also used for woollen piece-goods having cotton and silk effects. — On **Silk** largely employed for dark compound colours. — In dyeing **Wool-cotton** and **silk-wool unions,** also **shoddy goods.** — In **wool** and **silk-printing.** — In **Leather-dyeing.** — Much used for **Jute** and **Cocoa-nut fibre.** — Very extensively used in **Paper-dyeing** for colouring paper-pulp and in paper-staining. — As barium and lead lakes on the most varied bases, largely used in the manufacture of **colour-lakes** for wall-papers, paper-staining, lithographic colours, and paints.

Scarlet 3 R.

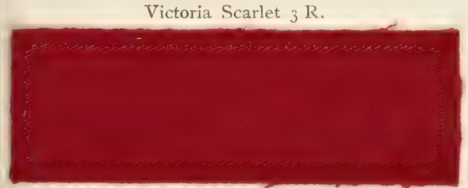
Scarlet 4 R.

Brilliant Lake Scarlet R.

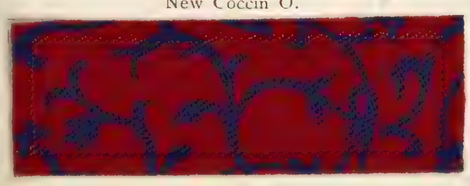


In **Cotton-dyeing** for yarn and piece-goods, when fastness to light is demanded, but not fastness to water or washing. — In **Wool-dyeing** largely used for weft-yarns, also if only a slight milling with soap or cold water is required, for knitting, embroidery, fancy, and carpet-yarns; also on slubbing; further in piece-dyeing for cashmeres, ladies dress-goods, and knitted-goods, as a self-colour, scarcely ever in combination with other colours. — In **Silk-dyeing** chiefly for yarn as self-colours. — In the **printing** of **wool, silk,** and **wool-cotton unions.** — On **Jute, Cocoa-nut fibre, Straw,** and **Feather** dyeing. — In the manufacture of **paper** especially used for colouring the paper by dipping and by staining. — In **Leather-dyeing.** — Very largely used in the manufacture of **colour-lakes** as a barium lake on various bases, for making so-called Turkey-red lakes for paper-staining and for wall-papers, further for lithographic colours and for body-colours in oil paints, either alone or shaded with other colours.

Victoria Scarlet 3 R.



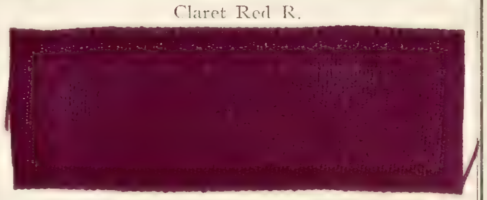
New Coccin O.



In **Wool-dyeing** extensively used as self-colours because of their low price and excellent fastness to light-both for yarns and piece-goods in place of the Scarlets wherever fastness to milling and to sulphur (stoving) is not required, (except in the case of Crystal Scarlet, which is fast to stoving). — Much used also in dyeing **wool-cotton unions** for dyeing the wool only, also in silk-wool unions, since the silk does not dye in the presence of wool. — In silk-dyeing their use is limited, but in **wool-printing** they are extensively employed chiefly for scarlet prints and for discharging. — In **Leather-dyeing,** also in **Paper-dyeing** used especially for colouring by dipping and staining. — In the manufacture of **colour-lakes** they find a limited use.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Fast Red (O, S) **Roccelline** (N)	1877/78	Dissolve in boiling water; solutions which have been standing for some time should be warmed before use.	Dye in an acid bath with the addition of 10 % Glauber's salt and 3% sulphuric acid; enter at 50° C. (120° F.), raise to the boil and boil 1 hr.; or dye at the boil with the addition of acetate of ammonia and add sulphuric acid gradually.		Dye in an acid bath containing boiled-off liquor, enter at 50°–60° C. (120°—140° F.) and raise to the boil; brighten with sulphuric acid.
Amaranth (O, E) **Victoria Rubine** (O, G) **Naphthol Red** (O) **Brilliant Crimson** (O, B) **Brilliant Rubine** (O)	1878 1883	Dissolve in boiling water.	Dye in an acid bath with the addition of 10 % Glauber's salt and 3% sulphuric acid; enter at 50°—60° C. (120°—140° F.) raise to the boil and boil 1 hr.		Dye in an acid bath containing boiled-off liquor, enter at 50°—60° C. (120°—140° F.) and raise to the boil; brighten with sulphuric acid.
Claret-Red (G, R, B, 3B, G, R, B extra, O, S)	1878	Dissolve in boiling water, but not in the acid dye-bath.	Dye in an acid bath with the addition of 3% sulphuric acid and 10 % Glauber's salt; enter at 50° C. (120° F.) raise to the boil and boil 1 hr.; or dye with the addition of acetate of ammonia and add sulphuric acid gradually.		Dye in an acid bath containing boiled-off liquor, enter at 50°-60° C. (120°-140° F.) and raise to the boil; brighten with sulphuric acid.

Azo Colours.

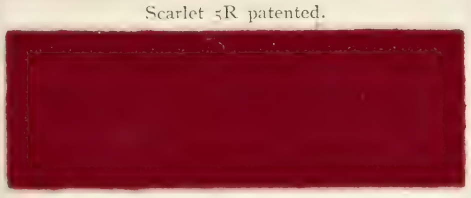
Employment	Dyed Patterns
In **Wool-dyeing** very largely used on tops, yarn, piece-goods, and plush for dark reds as a cheap red colour fast to alkali and washing and satisfactorily so towards light. — In **Silk-dyeing** also much used, for dark red and brown. — Used also in **wool** and **silk-printing.** — Employed in the dyeing of **wool-cotton unions** and **shoddy material** for dyeing the wool. — Also in **Jute-dyeing** and **printing.** — In Paper-dyeing used for colouring paper pulp and for staining.	Fast Red S.  Fast Red O. 
In **Wool-dyeing** used on yarn and piece-goods of all kinds as a ground colour for garnet-red, claret-red, red, and red-brown, either alone or shaded with other acid-colours in great variety; very fast to light, fast to alkali, and cheap; on cheap dress-goods for men's wear, also used for brown and navy-blue. — On **Silk** its use is limited. — Used in **Wool-printing,** and to some extent also in **Leather-dyeing.** — In **Paper-dyeing** employed for colouring paper-pulp, for dipping, and staining. — Used also for dyeing **Jute**, **Cocoa-nut fibre,** and **Straw.**	Victoria Rubine O.  Naphthol Red O. 
In **Wool-dyeing** on yarn, piece-goods, and slubbing somewhat largely used as a grounding for full red and bluish-red standard colours. — Also in **Silk-dyeing** largely used for full red shades. — Used in **Wool** and **Silk** and **printing.** — In **Leather-dyeing,** also in the **dyeing** and **printing** of **Jute.** — In the manufacture of paper used for colouring paper-pulp and for staining fancy coloured papers. — Used in the manufacture of **Pigment colours** as a barium or lead lake for bluish-red and full red colours either alone or in mixtures, or shaded with magenta or violet.	Claret Red B.  Claret Red R. 

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Scarlet (B extra) **Scarlet** (5R) patented **Brilliant Croceïn** (yellow shade, blue shade, R, B, BB, 3B, 5B) **Paper Scarlet** (yellow shade, blue shade, 3B) **Red** (Y, YB, YG, Y2G) patented	1880 1881 1882, 83	Dissolve in boiling water.	Dye in acid bath with the addition of 3% sulphuric acid and 10% Glauber's salt; enter at 50° C., raise to the boil and boil 1 hr.	1. Dye in a strong salt bath 6°—8° Tw., and dry without washing. 2. Mordant with basic alum solution, and dye in a fresh bath. 3. I Bath: stannate of soda. II Bath: basic alum solution. III Bath: dye. 4. Dye in single bath at 40°—50° C. (105°—120° F.) with addition of 40% common salt and 10% alum. The dyebaths are preserved for further lots of material.	Dye in an acid bath containing boiled-off liquor; enter at 50°—60° C. (120°—140° F.), raise to the boil and continue dyeing just below the boil. Brighten with sulphuric acid.
Cloth Red (O) **Fast Claret Red** (O)	1879/80	Dissolve in boiling water.	1. Dye in an acid bath with addition of 3% sulphuric acid and 10% Glauber's salt; enter at 30°—40° C. (85°—105° F.), raise to the boil and boil 1 hr. 2. Boil with dyestuff and tannin matter and fix with sulphate of iron 3. Boil with addition of acetic acid and Glauber's salt and fix in the same bath with bichrome or chromium fluoride.		Dye in an acid bath containing boiled-off liquor, enter at 50° C. (120° F.) and raise to the boil; brighten with sulphuric acid.
Solid Brown (O, yellow shade, L, NT) **Azo Brown** (V)	1879	Dissolve in boiling water.	Dye in an acid bath with the addition of 3% sulphuric acid and 10% Glauber's salt; enter at 50°—60° C. (120°—140° F.), raise to the boil and boil 1 hr.		Dye in an acid bath containing boiled-off liquor; enter at 50° C. (120° F.), raise to the boil, and continue dyeing just below the boil; brighten with sulphuric acid.
Azo Black (O) **Naphthol Black** (D)		Dissolve in boiling water, not in the acid dye-bath.	Boil with the addition of 15% Glauber's salt, after 1/2 hr. add gradually 4% sulphuric acid; or dye with the addition of 20% Glauber's salt and 10% acetic acid.		Dye in an acid bath containing boiled-off liquor; enter at 30°—40° C. (85°—105° F.), raise to the boil and dye for 1 hr. just below the boil.

Azo Colours.

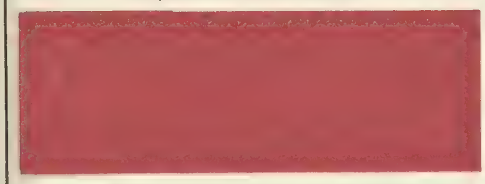
Dyed Patterns — Employment

Scarlet 5R patented.



Scarlet B extra.

Paper Scarlet blue shade.



In **Cotton-dyeing** used for yarn and piece-goods as brilliant self-colours satisfactorily fast to light, whenever fastness to water and washing is not required. — In **Wool-dyeing** used more particularly for yarn but also for piece-goods for self-colours which are very fast to light, and which also stand washing, and milling with water or a slight milling with soap. — On **Silk** much used since they give scarlets which are very fast to light. — On **silk-wool unions** for dyeing solid colours. — Used in **wool** and **silk-printing**. — Also used for dyeing **Jute, Cocoa-nut fibre**, and **Straw**. — Much employed in **Leather-dyeing** because so readily fixed. — In **Paper-dyeing** the various marks of Paper Scarlet are used for colouring paper-pulp, also for dipping and staining variegated papers. — In the manufacture of **Colour-lakes** the various marks of Paper Scarlet are used as barium lakes for fancy coloured papers, and wall papers; Scarlet B extra as a barium lake is specially used in imitation of vermilion for calico-printing.

Cloth Red O patented.

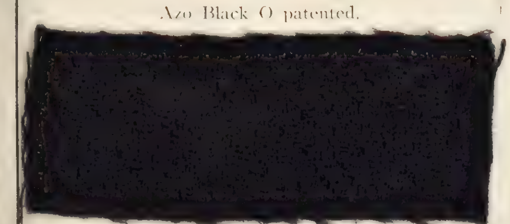
On **Wool** used both for loose-wool, tops, and yarn, as well as for heavy piece-goods, either alone or in combination with tannin matters and dyewoods; also for milled goods. — Used in **wool-printing** and **melanging**. — Finds limited use in the dyeing of **Silk, Leather**, and **Paper.**

Solid Brown O.

Fast Brown L.

On **Wool** used for brown shades in combination with other acid-colours, especially for weft and knitting-yarns and for woollen cloth. — On **Silk** used in considerable quantity along with other colours for dark brown and for grounding. — Used in **Wool** and **silk-printing**. — Used also for **Leather, Jute, Cocoa-nut fibre, Straw, Wood.** — Very much used in **Paper-dyeing** for colouring paper-pulp and for staining. — In the manufacture of **Colour-lakes** employed as a barium precipitate for producing brown lakes intended for variegated papers, wall papers, lithographic and water colours.

Azo Black O patented.



In **Wool-dyeing** used for yarn, especially weft-yarns for cold and hot-water milling and for piece-goods especially dress-goods, also for goods showing cotton thread effects; distinctly faster to light, wear, and acid than logwood black. — In **Silk-dyeing** finds limited use as a self-colour. — Used in **Wool** and **silk-printing**. — Used also in **Paper-dyeing**.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Azo Acid Black (G, B, R) patented	1894	Dissolve in boiling water.	Dye at the boil in an acid bath with the addition of 10% Glauber's salt and 3% sulphuric acid, or with 8% bisulphate of soda. It dyes very level shades.		
Azo Acid Blue (B) patented **Victoria Violet** (4BS and 8BS) patented	1894 1890 1891	Dissolve in boiling water, or if necessary it may also be dissolved in the acid dye-bath.	Dye at the boil with the addition of 10% Glauber's salt and 4% sulphuric acid, or with 10% bisulphate of soda. In old dye-baths it dyes very level; when matching it may be added at once to the dye-bath if necessary; with the addition of alum it dyes a bluer shade.		
Chromotrope (6B, 2B, 2R) patented **Azo Acid Magenta** (G, B) patented **Orchil Substitute** (G) patented	1890	Dissolve in boiling water; Chromotrope 2R, 2B and 6B may also be dissolved at once in the dye-bath.	Dye at the boil with the addition of 10% Glauber's salt and 4% sulphuric acid, or with 10% bisulphate of soda; with addition of alum the shade is bluer. It dyes level at the boil, even when small additions are made to the bath.		

Azo Colours.

Employment	Dyed Patterns

In **Wool-dyeing** used for zephyr, mohair, and fancy yarns, where special fastness to milling and washing is not required; for light **ladies' dress-goods** (cashmeres, etc.) also such as show cotton thread effects, and in **Garment-dyeing.** — Equal in appearance to a logwood black, but a **single-bath colour** easy to dye and to match. — In **Wool-printing** used for direct-printing and for the production of dyed piece-goods printed afterwards with discharge colours.

Azo Acid Black G patented.

Azo Acid Black G patented.

In **Wool-dyeing** used for slubbing intended for knitting-mixture-yarns; on **weft-yarns** intended for a slight milling with soap or with water; on knitting and stocking-yarns, and on light woollen and worsted goods, used as an **exceedingly cheap grounding-colour** for navy-blue and Russian-green, especially in combination with Indigo Substitute B and BS. — In **Wool-printing** used alone and in combination with other colours for direct-printing, also used along with other azo-colours for producing white and coloured discharges on dyed grounds, e. g. blue, brown, green, and fancy colours. — On **Silk-wool unions** used for dyeing the wool and leaving the silk white.

Victoria Violet 4BS patented.

Azo Acid Blue B patented.

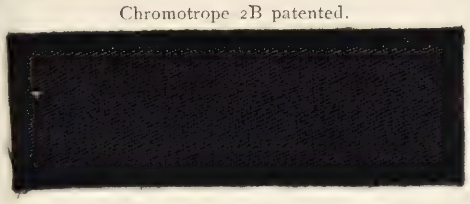
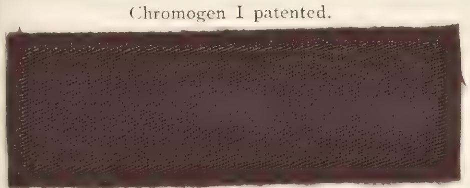
In **Wool-dyeing** used on yarn and piece-goods as a very level-dyeing acid-red colour extremely fast to light, for all kinds of compound colours; Orchil Substitute, Chromotrope 2 R, and Azo Acid Magenta are also used for the palest fancy shades. — Azo Acid Magenta and Chromotrope 6 B are specially to be recommended, in combination with Patent Blue V, VV, VVS, for the production of very good wearing navy-blues. — Chromotrope 2 R being exceptionally fast to light is very useful either as a self-colour or in combination, for dyeing carpet-yarns and plushes. — Very much used in **Wool-printing** both alone and along with other colours because of its ready solubility and it is so well fixed. — Chromotrope 6 B and 2 R are also used in the dyeing of **silk-wool unions** for shot-effects, since the wool alone is dyed.

Chromotrope 2R patented.

Azo Acid Magenta G patented.

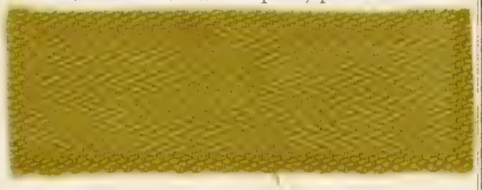
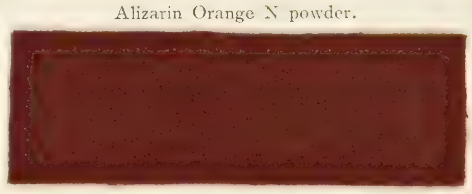
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing		
			Wool	Cotton	Silk
Chromotrope (S, SB, SR, FB, 8B, 10B, 2B) patented.	1890/94	Dissolve in boiling water.	Dye with the addition of 3% sulphuric acid and 25% Glauber's salt, or with 4% hydrochloric acid and 25% Glauber's salt, enter at 60° C. (140° F.), raise to the boil, boil 1 hr., then add 3% bichromate of potash or soda and continue boiling 1—1½ hrs. One may also develop with bichrome in a separate bath, and thus use both the dye-bath and developing bath for successive lots of material.		
Chrome Brown (RO, BO)	1893	Dissolve in boiling water, preferably with the addition of a little soda; pour the solution into the dye-bath through a sieve.	Dye with the addition of 3% sulphuric acid and 25% Glauber's salt; enter at 60° C. (140° F.), raise to the boil and boil 1 hr., then add 3% bichromate of potash or soda and 1% sulphuric acid, and continue to boil 1—1½ hrs. One may also develop with bichrome in a separate bath, and thus use both the dye-bath and developing bath for successive lots of material.		
Chromogen I patented	1891	Dissolve in boiling water.	Dye at the boil with the addition of 4% sulphuric acid and 10% Glauber's salt, or with 10% bisulphate of soda, then develop in the same or a separate bath with bichromate of potash and sulphuric acid.		

Azo Colours.

Dyed Patterns	Employment
Chromotrope S patented.  Chromotrope 2B patented.  Chromotrope 10B patented. 	In **Wool-dyeing** used on **loose-wool** for a fast solid black; on **Slubbing** for knitting-mixture-yarn and melanges for milling with water; on **weft-yarn** for milling with water or soap; in **Piece-dyeing** on all kinds of dress-goods, especially Chromotrope S, as a **very fast black withstanding the most varied influences in the best possible manner,** also, especially Chromotrope FB, in combination with Patent Blue V, Ketone Blue, or Water Blue, for a very good wearing and cheap navy-blue; further, on loose-wool for plain coloured goods and piece-goods for topping vat-indigo-blue, and on piece-goods (Cashmere) as a ground for logwood. — In **Wool-printing** on piece-goods used both alone and in combination for black and blue, also in melange-printing on slubbing.
Chrome Brown RO. 	In **Wool-dyeing** used on **loose-wool** for a solid brown, on **slubbing** for knitting-mixture-yarn and for milling with water, on **weft-yarn** for milling with soap or water, in **piece-dyeing** on dress-goods and cloth for a cheap, good wearing brown, fast to acid; — can be shaded in the same bath with acid-colours fast to chroming.
Chromogen I patented. 	In Wool-dyeing as a single-bath brown **absolutely fast to milling** used in combination with fast acid-colours or acid-alizarin-colours for fancy shades and for brown, also on **weft-yarn** of all kinds, on **knitting** and **stocking-yarn,** on warps fast to milling and to acid, on **slubbing** of all kinds, and on **piece-goods** (namely both light and heavy worsteds and knitted goods) for brown and fancy colours.

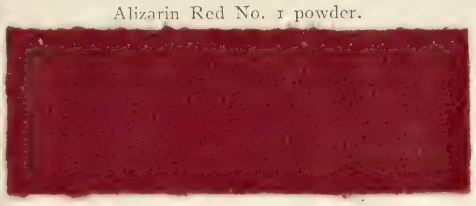
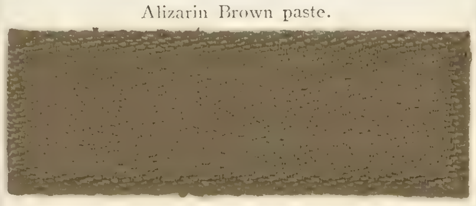
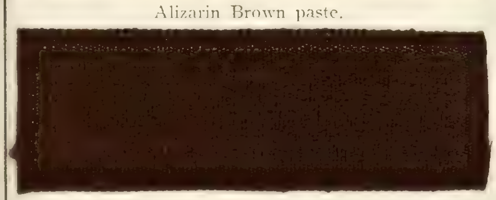
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Cotton	Silk
Alizarin Yellow (GG, R, GGW, RW paste, GGW and RW powder) **Mordant Yellow** (O)	1887/88	Make into a paste with water, which should be as free from lime as possible and pass through a sieve into the dye-bath. The powder colours are dissolved in boiling water, condensed water if possible.	1. Dye by the two-bath method on bichrome and tartar, or better still on bichrome and sulphuric acid mordant, with addition of acetic acid to the dye-bath. 2. Boil with the addition of 3–4% sulphuric acid and 10% Glauber's salt, then develop in the same or in a separate bath with bichromate of potash, fluoride of chromium, or alum.	Mordant with chromium mordant GAI or GAII, dry, then fix in a hot solution containing 50 grams soda per litre, wash and dye in a bath acidified with acetic acid.	Steep over-night in chromium mordant GAIII, wash well, and dye, entering cold and raising gradually to the boil. Brighten with tartaric or acetic acid.
Alizarin Yellow (paste)	1887	Make into a paste with water as free from lime as possible, and add to the dye-bath through a sieve.	Mordant with bichrome and tartar and dye in a separate bath acidified with acetic acid; enter at 30–40° C. (85–105° F.) raise to the boil and boil 1–1½ hrs.		
Alizarin Orange (N,G, paste and powder)	1876	Make into a paste with water as free from lime as possible, and add to the dye-bath through a sieve. The powder colours are dissolved in boiling water.	Mordant with bichrome and tartar, or bichrome and sulphuric acid, or alum and tartar, and dye in a separate bath; enter at 30°–40° C. (85°–105° F.), raise slowly to the boil and boil 1–1½ hrs.	Dye according to one or other of the following processes: 1. On Turkey-red mordant. 2. On chromium mordant. 3. Erban and Specht's method.	Mordant with the nitrate of alumina at 18° Tw., wash well, and dye in a bath containing boiled-off liquor, enter cold and raise gradually to the boil; soap well and brighten with tartaric acid.

Colours.

Employment	Dyed Patterns
In **Wool-dyeing** much used on loose-wool as a fast substitute for Old Fustic, chiefly in combination with other alizarin-colours, further for shading single-bath colours dyed with Chromogen I. — On **Slubbing** dyed after mordanting in combination with alizarin-colours, or in single-bath with Chromotrope S, FB, Chrome Brown, Chromogen, and acid alizarin-colours for heavy milling and for milling with water only. — In **Yarn-dyeing** chiefly used for weft-yarn for milled goods, but also for fast dyed knitting, stocking, and carpet yarns. — On **Piece-goods** used as one of the fastest yellows for shading in combination with alizarin-colours, for **fast green** on a vat indigo ground, further as a fast yellow used in combination with Chromotrope S, FB, Chrome Brown RO, Chromogen I, and acid alizarin-colours, dyed in single-bath. — Used very largely for **slubbing-printing** for melanges. — On **Silk** used in hank-dyeing for colours fast to washing. — In **Calico-printing** used as a chrome-steam-colour for full compound colours, and fancy shades, and as a self-colour in combination with alizarin and basic colours, further as a yellow dyestuff in the production of dyed styles on chrome-mordant prints or resist. — In **Cotton-dyeing** used on loose-cotton-wool, piece-goods, and yarn, with chrome mordant as a fast yellow, chiefly in combination with other alizarin-colours. — In the manufacture of **Colour-lakes** used for giving a fast yellow for lithographic printing.	Alizarin Yellow GG paste, patented.  Alizarin Yellow GGW powder, patented.  Alizarin Yellow GG paste, patented.  Alizarin Yellow RW paste. 
Employed exclusively in **Wool-dyeing** for producing fast colours on loose-wool, slubbing, and yarn, intended for heavy milling; occasionally as a self-colour, but chiefly for shading compound and fancy colours in combination with other alizarin-colours. It is remarkable for its greenish shade of yellow and its extreme fastness. It is employed further in **hat-dyeing** for fancy shades because it dyes so level and so well through.	Alizarin Yellow paste. 
In **Cotton-dyeing** used on loose-cotton-wool, and very largely for yarn and piece-goods both alone and in combination with other alizarin-colours for all fast dyed goods. — In **Wool-dyeing** used on **loose-wool, slubbing, worsted** and **woollen yarn** for buckskins and all kinds of milled goods, chiefly for compound shades in combination with other alizarin and wood colours, less frequently on alumina mordant as a self-colour; in **piece-dyeing** chiefly for heavy dress-goods for men's wear, also for hat-dyeing in combination with alizarin and wood colours for producing brown shades. — In **Silk-dyeing** used in hank-dyeing both alone and along with other alizarin-colours, also on silk weighted with tin for colours fast to washing and light. — In **Calico-printing** used for steam-colours with chrome or alumina, further for dyed styles on mordants with print or resist patterns, used either alone or along with other colours. — Used in **wool, silk,** and **slubbing-printing**. — In the manufacture of **Colour-lakes** used as an alumina-lake for lithographic printing colours.	Alizarin Orange N powder.  Alizarin Orange N paste.  Alizarin Orange G paste. 

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Alizarin Red (Nr. 1B new, Nr. 1, 2A bl. bl., 2A, 2AW, 2BW, 1W, RX, 2W, 3W, 3GW, 4FW, SDG, GG, F, paste, Nr. 1 powder)	1869/70	Make into a paste with water and add to the dye-bath through a sieve. The powder colours are dissolved in caustic soda and borax and precipitated in the dye-bath with hydrochloric acid.	1. Mordant with alum and tartar, and dye in a separate bath with the addition of acetate of lime and tannin matter. 2. Mordant with bichrome and tartar, or bichrome and sulphuric acid and dye in a separate bath, with addition of acetic acid sufficient to correct the water if calcareous.	Dye according to one or other of the following methods: 1. On the Turkey-red mordant, old or new process. 2. On chromium mordant. 3. On iron mordant. 4 By Erban and Specht's method.	Mordant with nitrate of alumina at 18° Tw. and wash well. Dye in a bath containing boiled-off liquor entering cold and raising gradually to the boil; soap well and brighten with tartaric acid.
Alizarin Brown (paste, Rpaste, G paste, powder, R powder)	1882	Make into a paste with water free from lime, and add to the dye-bath through a sieve; the powder colours are dissolved in boiling water free from lime.	Mordant with bichrome and tartar or bichrome and sulphuric acid, and dye in a separate bath with the addition of acetic acid to correct the water if calcareous.	Dye on Turkey-red mordant, aluminium and iron mordant, or on chromium mordant.	Mordant with nitrate of alumina, wash, and dye in a bath containing boiled-off liquor, entering cold and raising gradually to the boil; soap, and brighten with tartaric acid.

Colours.

Dyed Patterns	Employment
Alizarin Red No. 1 powder.  Alizarin Red 2BW paste 20%.  Alizarin Red RX paste 20%.  Alizarin Red IB new paste 20%. 	In **Cotton-dyeing** used for **Turkey-red** and **pink** in very large quantities on **all kinds of yarn** and **piece-goods,** also on loose-cotton-wool and roving, further for fast compound shades on yarn and piece-goods with alumina, chrome, iron, and mixed mordants either alone or in combination with other alizarin-colours and dyewoods. — In **Wool-dyeing** used on **loose-wool** for so-called madder-red on army-cloth, also for all kinds of compound shades in combination with alizarin-colours and dyewood-extracts, on **slubbing** and **worsted yarn** for buckskins and milled goods of all kinds, also in dyeing the Turkish fez and in **hat** and **piece-dyeing.** — On **Silk** used in hank-dyeing for compound shades fast to water, washing, and light and for self-colours. — In **Calico-printing** used very largely as a **steam-colour** with **alumina, iron,** and **chrome mordants,** also mixed mordants, and in combination with other alizarin-colours, dyewood-extracts, catechu, and basic-colours for producing red, pink, violet, lilac, chocolate, garnet-red, bordeaux, brown, and other compound shades; used also for the production of dyed print, resist, and discharge styles of the most varied kind with alumina, iron, chrome, and mixed mordants etc. etc. — In the manufacture of **Colour-lakes** used for making so-called madder-lake and madder-pink for lithographic and artists' colours.
Alizarin Brown paste.  Alizarin Brown paste.  Alizarin Brown paste. 	In **Wool-dyeing** used in very large quantities for **loose-wool,** alone and in combination with other alizarin-colours as a very fast brown for wool-dyed cloth, buckskins, and milled goods of all kinds; on **slubbing, worsted, knitting,** and **stocking yarns** alone and with other colours for milled goods of all kinds and for fast colours on knitted goods; in **piece** and **hat-dyeing** used for browns and fancy colours. — In **Cotton-dyeing** chiefly used for fast dyed yarns. — In **Silk-dyeing** used in hank-dyeing, also on silk weighted with tin for brown and fancy colours fast to water, washing and light. — In **Calico-printing** used for **steam-colours** chiefly with other colours and for the production of **chrome-dyed styles.** — In Wool-printing chiefly used for printing slubbing for melanges. — Used also in **Silk-printing.** — Used for dyeing **wool-cotton unions** and also **silk-wool unions** (Gloria) in fast colours. — In the manufacture of **Colour-lakes** used for lithographic colours. — Used for colouring **Soaps.**

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Alizarin Blue (DN, DNW, DNX, F, A, R, RR) paste **Alizarin Dark Blue** (S) paste	1877	Make into a paste with water free from lime, and add to the dye-bath through a sieve.	Mordant with bichrome and tartar and dye with the addition of acetic acid, enter at 30° C. (85° F.), raise slowly to the boil and boil $1^1/_2$ $2^1/_2$ hr. If the goods dye level with difficulty the acetic acid is only added towards the end of the dyeing operation.	Prepare the material with oil, then mordant with chromium mordant GAI or GAII and fix with soda. — Dye with the addition of acetic acid, entering cold and raising gradually to the boil.	Mordant with nitrate of alumina, wash, and dye with the addition of boiled-off liquor, entering cold and raising gradually to the boil, then soap and brighten with tartaric acid.
Alizarin Black (P, S) paste patented	1892	Make into a paste with water free from lime and add to the dye-bath through a sieve.	Mordant with bichrome and tartar and dye with addition of acetic acid entering at 30° C. (85° F.), raising slowly to the boil, and boiling $1^1/_2-2^1/_2$ hrs.	Prepare with Turkey-red oil, mordant with chromium mordant GAI or GAII and fix with soda. — Dye with the addition of acetic acid entering cold and raising gradually to the boil.	Mordant with nitrate of alumina, wash, and dye with the addition of boiled-off liquor entering cold and raising gradually to the boil, then soap and brighten with tartaric acid.
Alizarin Green (S) paste patented	1893	Dissolve in tepid water free from lime.	Mordant with bichrome and tartar and dye with the addition of acetic acid, enter at 30° C. (85° F.), raise gradually to the boil and boil $2^1/_2$ hrs.	1. Prepare with Turkey-red oil, mordant with chromium mordant GAI or GAII and fix with soda, then dye with the addition of acetic acid. 2. Employ Erban and Specht's process.	Mordant with nitrate of alumina, wash, and dye with the addition of boiled-off liquor, entering cold and raising gradually to the boil; brighten with tartaric acid.

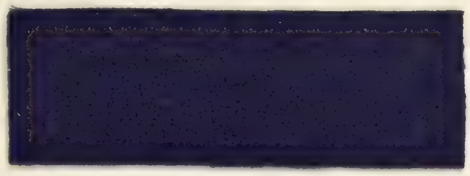
Colours.

Employment

Dyed Patterns

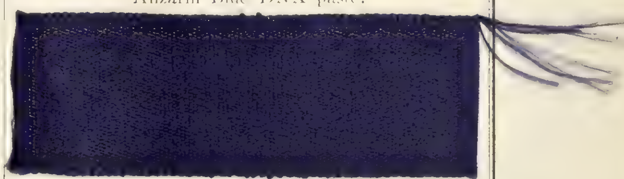
In **Wool-dyeing** used in very large amount as a substitute for vat-indigo blue on **loose-wool, slubbing** and **yarns of all kinds,** as a self-colour and in combination with other alizarin-colours for compound and fancy shades, as a blue fast to milling, wear, and acid; in **hat dyeing** and for dyeing dress-goods for men's wear in the piece. — In **Cotton-dyeing** chiefly used on oil and chromium mordant for fast dyed yarns as a self-colour and also in mixtures. — In **Silk-dyeing** used for hank-dyeing, also on silk weighted with tin, for blue and fancy colours fast to water, washing, and light. — Used also for dyeing Gloria. — In **Calico-printing** used chiefly as a steam-colour in the bisulphite form, but also for dyed styles on chromium mordant. — In **Wool-printing** used for printing slubbing for melanges. — Used also for colouring **Soaps.**

Alizarin Blue A paste.



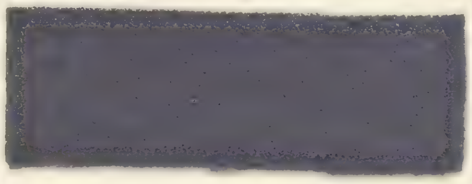
Alizarin Blue DN paste.

Alizarin Blue DNX paste.



In **Wool-dyeing** used as a self-colour and in combination with other alizarin-colours on loose-wool, tops, and yarn for buckskins, and milled goods of all kinds, and in **piece-dyeing** for better classes of dress-goods, as well as in **hat-dyeing.** — On **Cotton** chiefly for dyeing fast greys on yarn. — On **Silk** used in hank-dyeing as a self-colour fast to water, washing, and light. — In **Calico-printing** used as a **steam-colour** for fast grey and black, also in combination with other alizarin-colours. — Used also in **slubbing-printing** for melanges.

Alizarin Black P paste, patented.



Alizarin Black S paste, patented.

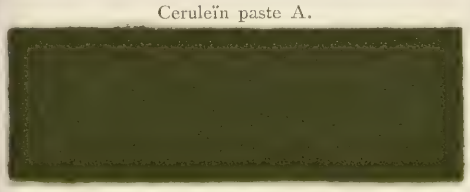
In **Wool-dyeing** used as a self-colour and in combination with other alizarin-colours on loose-wool, tops, yarn, and piece-goods. — In **Cotton-dyeing** chiefly used for fast fancy green shades. — In **Calico-printing** used chiefly as a steam-colour for producing a myrtle-green self-colour. — Used also in **Slubbing printing** for melanges.

Alizarin Green S paste, patented.

Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Ceruleïn (conc., S, paste A, paste SW)	1881	The S brands are dissolved in water free from lime; the paste colours are mixed with water and added to the dye-bath through a sieve.	Mordant with bichrome and tartar and dye in a separate bath; enter cold, raise slowly to the boil, boil $1^1/_2-2^1/_2$ hrs and add gradually some acetic acid.	1. Prepare with Turkey-red oil, mordant with chromium mordant GAI or GAII, fix with hot soda, wash, and dye with the addition of acetic acid. 2. Employ Erban and Specht's process.	Steep in nitrate of alumina at 18° Tw., wash well, and dye with addition of boiled-off liquor, entering cold and raising gradually to the boil; soap, and brighten with tartaric acid.
Galleïn (conc., W powder, paste A, paste R)	1881	Make into a paste with water free from lime, or dissolve in sodium carbonate or phosphate.	Mordant with bichrome and tartar, and dye in a separate bath with the addition of acetic acid; enter at 30°–40° C. (85°—105° F.), raise to the boil, and boil $1-1^1/_2$ hrs.	1. Mordant with chromium mordant GAI or GAII, fix in hot soda solution, wash, and dye with addition of acetic acid, entering cold and raising gradually to the boil. 2. Employ Erban and Specht's process.	Steep in nitrate of alumina at 18° Tw., wash well, and dye with addition of boiled-off liquor entering cold and raising gradually to the boil; soap and brighten with tartaric acid.
Alizarin Claret (R) paste	1892	Make into a paste with water free from lime, and add to the dye-bath through a sieve.	Mordant with alum and tartar, or bichrome and tartar, and dye with the addition of acetic acid entering at 40°—50° C. (105°—120° F.) and raising gradually to the boil.	1. Dye on Turkey-red mordant. 2. Mordant with chromium mordant GAI or GAII, and dye in a separate bath with addition of acetic acid. 3. Employ Erban and Specht's process.	Steep in nitrate of alumina at 18° Tw., wash well, and dye with the addition of boiled-off liquor entering cold and raising gradually to the boil; soap, and brighten with tartaric acid.

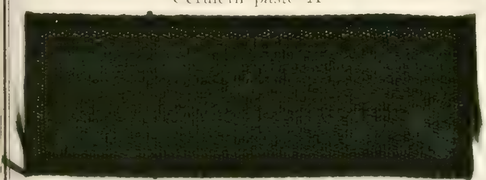
Dyed Patterns	Employment

Cerulein paste A.



Cerulein S.

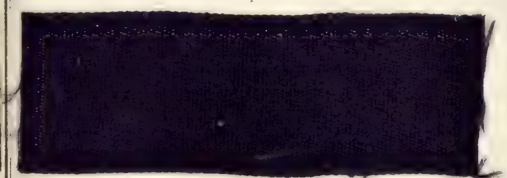
Cerulein paste A



In **Wool-dyeing** used on **loose-wool, slubbing,** and **yarn;** less frequently on **piece-goods** as a self-colour and in combination with other alizarin-colours for compound and fancy shades very fast to milling. — In **Cotton-dyeing** chiefly used on yarn for fast green and fancy shades. — On **Silk**, also when weighted with tin, for green and fancy shades fast to water, milling, and light. — In **Calico-printing** used chiefly as a chrome-steam-colour either alone or in combination with other alizarin-colours, but also for dyed styles on chromium mordant. — In **Wool-printing** its most important application is in **slubbing-printing** for melanges. — In the manufacture of pigment colours it is used for **green-lakes** for lithography and painting. — Used for colouring **toilet-soaps**.

Gallein W powder.

Gallein paste A.



Gallein paste A.

In **Wool-dyeing** largely used for **loose-wool, slubbing, yarns** of all kinds, and **piece-goods,** especially dress-goods, in combination with alizarin-colours, but for the most part used along with logwood for cheap navy blues and dark blues fast to milling. — In **Cotton-dyeing** used for yarn and piece-goods both alone and in combination with other colours. — On **Silk**, especially in the hank, used alone and in combination with other colours for giving shades fast to water, washing, and light. — In **Calico-printing** used as a chrome-steam-colour and for dyed styles both alone and in combination with numerous other colours. — Used also in **Wool and Silk-printing.** In the manufacture of **Colour-lakes** used for making fast violet lakes for painting and lithography. — Used also for colouring **toilet-soaps**.

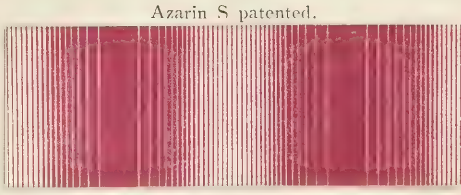
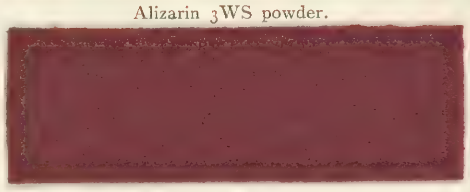
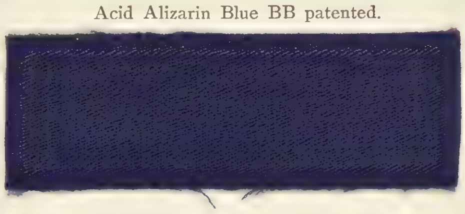
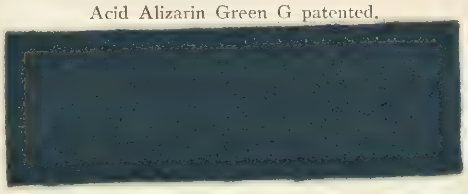
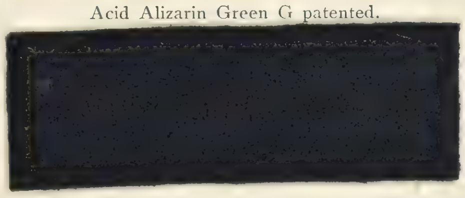
Alizarin Claret R paste.

Alizarin Claret R paste.

In **Wool-dyeing** chiefly used on **loose-wool** and **piece-goods** for bluing the shade of alizarin-red on alum and chrome mordants. — In **Cotton-dyeing** used on **yarn** and **piece-goods** less frequently as a self-colour than in combination with other colours for bordeaux and bluish-red shades in combination with alizarin-red. — On **Silk** used for fast bluish-reds either alone or in combination with alizarin red. — In **Calico-printing** used as a steam-colour with different mordants either alone or along with other colours, as well as for dyed styles. — In the manufacture of **Colour-lakes** used alone and in combination with alizarin for bluish-red lakes for lithography.

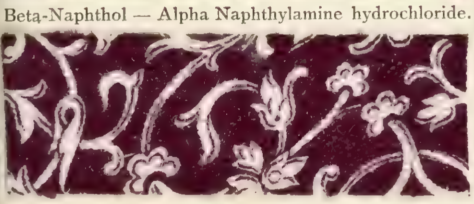
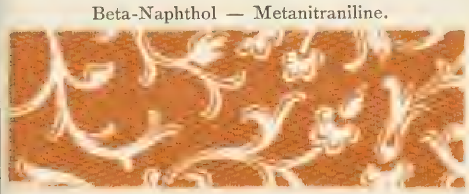
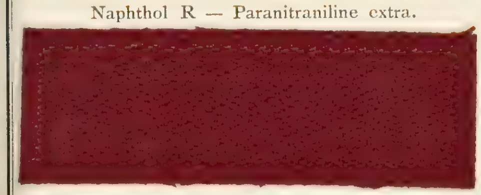
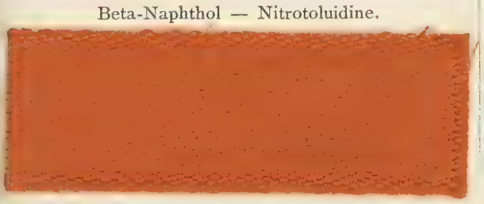
Commercial Name	Year of introduction	Mode of solution	Methods of Dyeing: Wool	Methods of Dyeing: Cotton	Methods of Dyeing: Silk
Azarin (S and R) patented	1883	Make into a paste with water as free from lime and iron as possible.	Mordant with alum, stannous chloride (tin crystals) and tartar.	Dye in Turkey-red mordant.	Mordant with nitrate or acetate of alumina and dye without any addition to the bath other than colouring matter; soap and brighten with tartaric acid.
Solid Green (O 50 %)	1875	Make into a paste with water, and add to the dye-bath through a sieve.	Mordant with bichrome and tartar, or with ferrous sulphate (copperas) and tartar.	1. Mordant with pyrolignite of iron, age, fix. 2. Mordant with chromium mordant GAI or GAII, fix, and dye. 3. Employ Erban and Specht's process.	Mordant with nitrate of iron, wash well, dye in aqueous solution, and soap well. Brighten with tartaric acid.
Alizarin Red (1WS, 2WS, 3WS, 4WS, and 5WS powder)	1876	Dissolve in boiling water as free from lime as possible.	1. Mordant with alum and tartar, bichrome and tartar, or bichrome and sulphuric acid, and dye in a separate bath. 2. Dye in single-bath with addition of alum and oxalic acid or tartar. 3. Dye at the boil with addition of 3% sulphuric acid and 10% Glauber's salt, and sadden in the same or a separate bath with alum, fluoride of chromium, or bichromate of potash.		
Acid Alizarin Blue (BB, GR) patented	1894/95	Dissolve in boiling water as free from lime as possible and add to the dye-bath through a sieve.	Dye at the boil with the addition of 3% sulphuric acid and 10-50% Glauber's salt, and sadden in the same or a separate bath by boiling $^3/_4$—$1^1/_2$ hrs. with 2—5% fluoride of chromium.		
Acid Alizarin Green (G) patented	1895	Dissolve in boiling water as free from lime as possible, and add to the dye-bath through a sieve.	Dye at the boil with the addition of 3% sulphuric acid and 25—100% Glauber's salt, and sadden in the same or a separate bath with 2—4% fluoride of chromium or 1—3% bichromate of potash.		

Colours.

Employment	Dyed Patterns
Scarcely ever used on wool, but in **Cotton-dyeing** it finds a limited use as a red which is very fast to washing and is brighter even than Turkey-red. — On **Silk** used for fast dyed embroidery yarn and weft-yarn for parasols and umbrellas. — In **Calico-printing** used as a brilliant self-colour and as a steam-colour with tin and alumina mordant. — It is most largely used in the manufacture of **Colour-lakes** for producing extremely brilliant **red** and **pink lakes** for lithography.	Azarin S patented. 
On **Wool** occasionally used for green and brown. — In **Cotton-dyeing** used as a self-colour fast to washing, especially with iron mordant on loose cotton-wool, yarn, and piece-goods. — In **Silk-dyeing** it finds only a limited use as a fast colour for hank-yarn. — In **Calico-printing** occasionally used as a steam-colour, but chiefly for dyeing on iron mordant both in prints and in resist styles.	Solid Green O 50%. 
On **Wool,** namely loose-wool, slubbing, all kinds of yarn, further for fez, hat-felt, and piece-goods, it is used alone for dyeing red, and along with azo red colours, or with other alizarin-colours on chromium mordant, or in acid bath with Chromogen I and acid alizarin-colours, it is used for dyeing all kinds of shades fast to milling, water, washing, and light. — In **Wool-printing** it is chiefly used for printing slubbing for melanges.	Alizarin Red IWS powder.  Alizarin 3WS powder. 
On **loose-wool,** especially for mixtures, less suitable for plain shades, it is used on **slubbing** and **worsted yarn** for the most varied shades of blue and fancy colours and compound shades, either alone or mixed with Alizarin Red WS powder, Alizarin Yellow GGW, Mordant Yellow O, and Acid Alizarin Green, as a blue which is **absolutely fast to milling** and does not bleed, and which is very fast to light and wear. — Used also on **knitting yarn.** — For **piece-dyeing** it is of very special importance, being used either alone or combined with the above named dyestuffs on all kinds of goods, because it gives very fast colours and well dyed through even on the hardest woven materials; the chief advantages are: saving of time, dyeing through, not rubbing off, and fastness equal to that of the alizarin-colours in paste form. — In **Slubbing-printing** for melanges it is used for fast blue and for compound shades.	Acid Alizarin Blue BB patented.  Acid Alizarin Blue GR. 
On **loose-wool**, especially for mixtures, it is used both alone and in combination with other colours, on **slubbing** and **yarns of all kinds,** and for milled goods it is specially suitable because it is **absolutely free from bleeding.** — If developed with fluoride of chromium it may be used along with Acid Alizarin Blue, Alizarin Red WS powder, Alizarin Yellow, Mordant Yellow, and all other acid-colours, if developed with bichrome it may be used with Chromogen I, Chromotrop-S, FB, Alizarin Red WS powder, Alizarin Yellow, Mordant Yellow, and all acid-colours not affected with bichrome. — Very suitable therefore in **piece-dyeing** for dyeing cloth and heavy dress-goods and light piece-goods for all kinds of fast colours. — It combines facility of application with the fastness of the alizarin-colours at present known.	Acid Alizarin Green G patented.  Acid Alizarin Green G patented. 

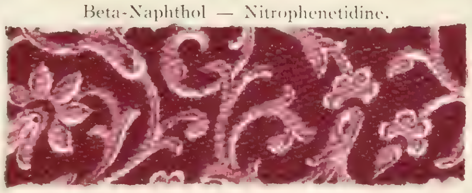
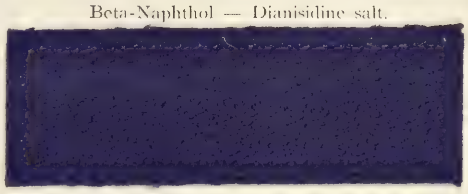
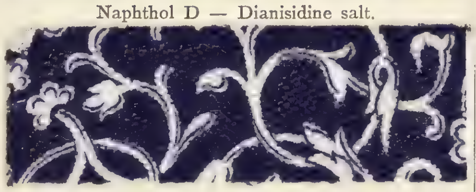
Commercial Name	Year of introduction	Mode of solution	Method of colour-production on cotton
Beta Naphthol Beta Naphthol (R) Naphthol (D) Alpha Naphthol	1888 1895 1894 1888	Dissolve in the form of its alkali compound by adding caustic soda.	Combine with diazo compounds, on the fibre.
Alpha Naphthylamine base, and hydrochloride BetaNaphthylamine base, and hydrochloride	1889 1889	Diazotise in the cold by treating the hydrochloride with sodium nitrite in the presence of excess of acid.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Aniline		Diazotise the hydrochloride, in the cold.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Metanitraniline	1890	Diazotise the hydrochloride or the nitrite paste, in the cold.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Paranitraniline	1889	Diazotise the hydrochloride or the nitrite paste, in the cold.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Nitrotoluidine	1890	Diazotise the hydrochloride or the nitrite paste, in the cold.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.

colours direct on the fibre.

Dyed Patterns	Employment
	For the production of insoluble azo-colours on the cotton fibre by the method of printing and dyeing, namely, in calico-printing, in plain dyeing, and in the dyeing of yarn and loose cotton-wool.
Beta-Naphthol — Alpha Naphthylamine hydrochloride.  Beta-Naphthol — Alpha Naphthylamine hydrochloride. 	Used in printing and in the dyeing of calico, cotton yarn, and loose cotton-wool. For the production, by means of Beta-Naphthol, of bright claret-red and garnet-red shades satisfactorily fast to washing and to light. By replacing part of the Beta-Naphthol sodium with Alpha-Naphthol sodium, darker garnet-red shades are obtained, but they are not so fast.
Beta-Naphthol — Beta Naphthylamine. 	Used in the printing and dyeing of cotton for the production of a very bright red of only limited fastness.
	When united with Beta-Naphthol it gives an orange used for printing details and outlines, but owing to its limited fastness it is seldom employed.
Beta-Naphthol — Metanitraniline. 	In union with Beta-Naphthol it gives the yellowest shade of orange among all the azo-colours produced direct upon the fibre, and finds a limited use in calico-printing.
Naphthol R — Paranitraniline extra. 	A splendid red, which is excelled by Turkey-red only in point of fastness. It is very extensively employed in plain colour dyeing, in printing, and in the dyeing of yarn and loose cotton-wool. The copper-lake is tobacco brown and satisfactorily fast to light, but sensitive to acid; it finds special use in calico-printing.
Beta-Naphthol — Nitrotoluidine. 	Orange colours of a bright reddish shade. Used in printing, for details and outlines, and resist-colours, because of their excellent fastness.

Materials required for producing

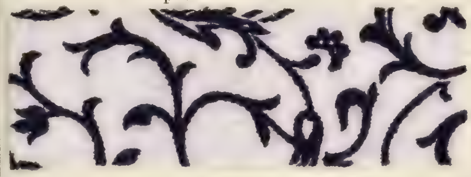
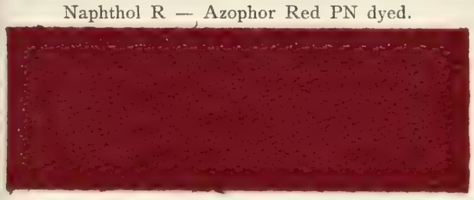
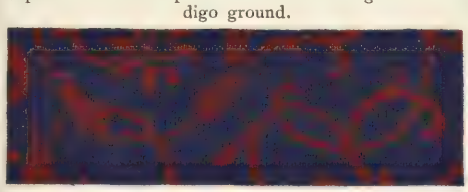
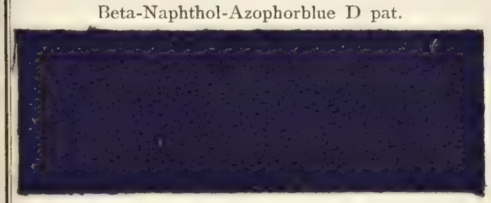
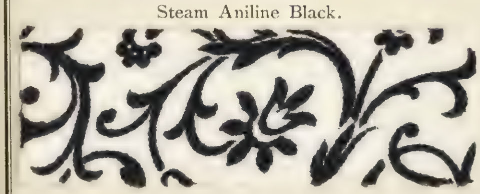
Commercial Name	Year of introduction	Mode of solution	Method of colour-production on cotton
Amidoazobenzene	1890	Diazotise the hydrochloride or the nitrite paste, without the use of ice.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Amidoazotoluene	1890	Diazotise the hydrochloride or the nitrite paste, without the use of ice.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Nitrophenetidine	1890	Diazotise the nitrite paste without the use of ice.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Benzidine **Benzidine sulphate** **Tolidine** **Tolidine sulphate**	1889	Diazotise the hydrochloride or sulphate, in the cold.	Combine the diazo solution neutralised with sodium acetate, chalk, etc., with alkaline naphthol solutions, on the fibre.
Dianisidine base **Dianisidine salt** **Dianisidine sulphate**	1893	Diazotise the hydrochloride or sulphate, or the nitrite paste, in the cold.	Combine the diazo solution, containing a copper salt, with Beta-Naphthol, Naphthol D, or Beta-oxy-naphthoïc acid m. p. 216° C. (420° F.), on the fibre.

Employment	Dyed Patterns
As a Beta-Naphthol azo-colour it gives a dull bluish-red of moderate fastness, capable of being readily discharged white; it is occasionally used in printing.	Beta-Naphthol — Amidoazobezene. 
As a Beta-Naphthol azo-colour it gives garnet-reds, which are useful in calico-printing and dyeing because of their excellent fastness and their similarity to the garnet-reds obtainable from alizarin.	Beta-Naphthol — Amidoazotoluene. 
As a Beta-Naphthol azo-colour it gives a very fast bluish-red employed in calico-printing for reds and pinks.	Beta-Naphthol — Nitrophenetidine. 
The Beta-Naphthol azo-colours are dark garnet-red and chocolate shades fairly fast to soap but less so towards light. The shade can be darkened, as required, by replacing a part of the Beta-Naphthol-sodium with Alpha-Naphthol-sodium. Chiefly used in calico-printing; not very suitable for dyeing yarn and loose cotton-wool.	Beta-Naphthol — Benzidine base.  Beta-Naphthol — Tolidine base. 
In combination with Beta-Naphthol it gives a bright blue possessing considerable fastness to soap and of exceptional fastness to light, but not fast to perspiration; in calico-printing it is advantageously employed in plain dyeing, giving with Naphthol D a darker and redder shade of blue, of great fastness and distinctly faster to perspiration. It is employed in the same manner. With Beta-oxy-naphthoïc acid m. p. 216° C. (420° F.) it gives a blue which is not so fast as the above and which is seldom used. By a treatment with copper the fastness is increased.	Beta-Naphthol — Dianisidine salt.  Beta-Naphthol — Dianisidine salt.  Naphthol D — Dianisidine salt. 

Materials required for producing

Commercial Name	Year of introduction	Mode of solution	Method of colour-production on cotton
Diazo Black salt	1894	Diazotise the hydrochloride, in the cold.	Combine the diazo solution containing sodium acetate and copper salt with Beta-Naphthol, on the fibre.
Azo Black base (O) and **Azo Black base** (ON, nitrite paste)	1895	Diazotise the nitrite paste, in the cold.	Combine the diazo solution neutralised with sodium acetate, with Beta-Naphthol, on the fibre.
Azophor Red (PN)	1895	Dissolves readily in cold water.	Combine the aqueous solution, neutralised with sodium carbonate, acetate, or hydrate, with Beta-Naphthol, on the fibre. Very well adapted for producing discharge-red on indigo ground after the chrome discharge method.
Azophor Blue (D) patented.	1895	Dissolves readily in cold water.	Combine the solution containing copper salt, with Beta-Naphthol, on the fibre.
Aniline		Dissolve in the form of hydrochloride, sulphate, tartrate, hydro-ferro-cyanide.	Print or dye in conjunction with oxidising agents and so-called oxygen carriers (compounds of copper, vanadium, &c.) and develop by ageing or steaming or by boiling in a dye-bath.

colours direct on the fibre.

Dyed Patterns	Employment
Beta-Naphthol — Diazoblack salt. 	The Beta-Naphthol azo-colour is a black very fast to light and soap, which is used in calico-printing chiefly for printing details and outlines. The black is suitable for the resist style.
Beta-Naphthol — Azoblack base O. 	It is employed in the same manner as the foregoing, giving a deeper black, which is very suitable for the resist style.
Naphthol R — Azophor Red PN dyed.  Naphthol R — Azophor Red PN discharged on Indigo ground. 	This is diazotised paranitraniline in a dry and stable form. The properties and mode of employment of the Beta-Naphthol azo-colour are the same as in the case of Paranitraniline. The dyebaths and printing-colours are more stable than when Paranitraniline is employed and the use of ice is unnecessary.
Beta-Naphthol-Azophorblue D pat.  Beta-Naphthol-Azophorblue D pat. 	This is tetrazotised dianisidine in a dry and stable form. The properties and mode of employment of the Beta-Naphthol azo-colour are the same as in the case of dianisidine. The dyebaths and printing-colours, which are prepared without the use of ice, are quite stable.
Steam Aniline Black. 	Aniline Black is the fastest known black, either to soap, soda, acid, or light, and is most extensively used on cotton and partly also on silk.

METHODS

FOR

FIXING THE DYESTUFFS ON THE FIBRE BY DYEING.

8

A.

General methods of Wool-dyeing.

In all the various processes of dyeing the wool-fibre, whatever form of material it may assume, it is perfectly obvious that if success is to be attained it must be as clean as possible, i. e. it must be free from yolk, dirt, size, oil introduced by the spinner, etc. The methods of scouring and preparing the wool previous to dyeing will be treated of in the second part of this work, when reference will be made to the influence they have upon the appearance of the dyes ultimately obtained. — In the following chapters the attention of the reader will be confined to the consideration of the different methods of wool-dyeing which have to be adopted according to the properties of the colouring matters employed. These methods are as follows:

I. Dyeing in neutral bath.
II. Dyeing in slightly acid bath.
III. Dyeing in acid bath.
IV. Dyeing in alkaline bath followed by a treatment with acid.
V. Dyeing in acid bath and developing with metallic salts.
VI. Mordanting with alum or chrome and dyeing in a separate bath.

I. The Dyeing in Neutral Bath.

Dyeing in a neutral bath is suitable for the so-called **Basic Colours.** This method is based upon the fact, that the wool-fibre combines with the colour-bases to form compounds having the character of salts, in which the wool plays the part of an acid, the base of the colouring matter acting as the base. — Owing to the weak acid character of the wool its affinity for the colouring matter is comparatively weak, hence the basic-colours dye very level shades. — It is usual to dye at or near the boil in neutral bath, i. e. without any addition, or with only a slight addition of acetic acid or alum. — Acetic acid retards the dyeing process considerably, since it retains the colouring matter in the solution, it also prevents precipitation and spotting; on the other hand small additions of soap are beneficial by increasing the brilliancy of the shade, especially in the case of **Magenta, Cerise, Grenadine, Methyl Violet,** etc.

Nearly all the basic-colours are sparingly soluble, and their bases are for the most part of a resinous character and insoluble in water. It is most important therefore that the colouring matters should first of all be thoroughly dissolved in hot water as pure and free from lime as possible, and this solution should be added to the dye-bath through a filter made of flannel or China-grass cloth. — The water of the dyebath should also be pure and free from lime. Calcareous water precipitates the colour-bases and consequently tends to produce spotting. Before adding the colour solution therefore it must be corrected with acetic acid, for which purpose, it is necessary to add $^1/_2$—1 litre acetic acid 12° Tw. per cubic metre of water; an excess of acetic acid however is to be avoided for the reasons stated above. If soap is added to the dye-bath, the water should be well boiled with the soap, and the sticky scum which is formed should be carefully skimmed off, before adding the colour solution. — Wool which has been bleached in the sulphur-stove, or by means of sulphurous acid solution, is not suitable for dyeing with the basic-colours.

This method of dyeing is employed with the following colouring matters: the various marks of **Magenta, New Magenta,** the various magenta residues e. g. **Cerise, Maroon, Rubine, Cardinal,** etc., **Methyl Violet, Primula, Violet crystals,** (the latter applied in a soap bath being important for stoved whites), **Phosphine, Yellow** for **Leather** and **Brown** for **Leather, Auramine, Vesuvine** and **Chrysoïdine, Brilliant Green, Malachite Green** and the **Rosazeines**.

For **Brilliant Green** and **Malachite Green** the following special process with sulphur mordant is frequently adopted because it gives brighter and faster dyes:

The wool is worked for 1 hr. at 60° C. (140° F.) in a wooden vessel, with:

15% thiosulphate of soda (hyposulphite),
3% sulphuric acid,
5% alum,

it is left lying in the bath for several hours, then well washed, and dyed in a fresh bath with Brilliant Green or Malachite Green.

The Rosazeines are weak basic-colours, and by virtue of their chemical character they form the connecting link between the basic and resorcine-colours. They are best dyed at the boil, in a slightly acid bath, with 10% acetic acid 12° Tw., if necessary however, they may be dyed in an acid bath e. g. along with azo-colours or other acid-colours.

As to the remaining basic-colours they are only used in combination among themselves, since with many other colouring matters, especially acid-colours and resorcine-colours, they form insoluble precipitates, which readily produce spotting. — Nevertheless, certain marks of **Methyl Violet,** also **Magenta** and **Green** are applied even in an acid bath, in many industries, for covering the burrs and bits of straw, etc. in woollen piece-goods. — In this case the goods are first boiled with the basic-colours without the addition of acid and then topped with acid-colours.

Since the basic-colours, by reason of their tendency to precipitate, readily give rise to 'dye-spots' on the goods, which it is extremely difficult, and as a rule impossible to remove from the wool, it is imperatively necessary, both in dissolving the colour and during the dyeing process, to pay strict attention to the above precautionary measures, since the defects produced cannot as a rule be removed.

With respect to the properties of the dyes obtained on wool by means of the basic-colours, they exhibit the following characteristic features: great brilliancy of shade, evenness of dye, good penetration, marked rubbing-off, want of fastness to light, and to water, but fastness to alkali, a great tendency to bleed, fastness to milling (but not if white fibres are present!), and moderate fastness to washing.

II. The dyeing in slightly acid bath.

The colouring matters which are dyed in a slightly acid bath are the **Resorcine Colours.** — In this method the wool plays the part of a base, and combines with the colour-acids of the resorcine-colours to form brightly coloured compounds having the character of salts. Since the wool is a somewhat strong base, the union of colouring matter with the fibre proceeds somewhat rapidly.

The method consists in first adding to the dyebath the requisite amount of colouring matter and 10% acetic acid, the material is then entered at 50°—60° C. (120°—140° F.), the bath is raised to the boil and boiled $^1/_4$—$^1/_2$ h. Another plan is to boil the material for $^1/_4$ h. with addition of

5% alum
5% cream of tartar
5% acetic acid 12° Tw.

the bath is then cooled to 50° C. (120° F.), the dyestuff is added, the temperature is again raised to the boil, and the boiling is continued for $^1/_4$—$^1/_2$ h. — Raising the temperature too rapidly, or entering the goods too hot, tend to produce uneven dyes.

The use of strong mineral acids must be avoided, because they prevent the colour-acid from combining with the wool and they dull the shades considerably.

This method is adopted when dyeing with: **Uranine,** the different marks of **Eosine, Erythrosine, Phloxine, Rose Bengal** and **Eosine Scarlet.** — The shades obtained are exceedingly pure and brilliant, and vary from the most delicate yellowish or bluish pink to a fiery scarlet or crimson. The Resorcine Colours are almost invariably employed as self-colours.

The dyes obtained with the Eosines are dyed through fairly well, they rub-off in the deeper shades, are very fugitive to light, rather sensitive to acid, fast to sulphuring, moderately fast to water, very fast to alkali, and of medium fastness to washing and milling.

III. The Dyeing in Acid Bath.

The method of dyeing in an 'acid bath' is of the greatest importance in wool-dyeing, and is very generally and extensively employed, on the one hand because the greatest number of colouring matters are applicable by this method — namely all the Acid Colours and Azo Colours, — and on the other hand because it can be rapidly carried out and is the method best adapted for wool. By the boiling in 'acid bath' the wool-fibre is very little affected, it retains its natural lustre and handle, and in the spun or woven material it retains the position given to it by previous treatment, moreover by this mode of dyeing the strength of the wool is very little injured. — In this method again the nature of the dyeing process is to be regarded as a salt or lake formation, in which the wool acts as a base, while the colour-acids (liberated by the acid employed, usually sulphuric acid) play the part of acids. — During the operation of dyeing, which takes place or is completed at the boil, most of the sulphuric acid employed is attracted and fixed by the wool simultaneously with the colouring matter.

What may be termed the 'normal' dyeing process in an acid bath, is as follows:

The dyebath is charged, along with the necessary amount of colouring matter, with 10% Glauber's salt and 4% sulphuric acid, or in place of these with 10% bisulphate of soda, (since in its action it corresponds exactly to 10% Glauber's salt and 4% sulphuric acid); the material to be dyed is then introduced, and with continuous handling of the material,

the temperature is raised to the boil; after boiling for $^3/_4$—$1^1/_2$ hrs. the dyeing process is complete. — Owing to differences in the material to be dyed, and because of the very varied properties of the numerous colouring matters which are applicable in an acid bath, it is found necessary in practice to change and modify to some extent this normal process of dyeing.

The merchant demands that the dyed goods shall exactly match the sample, that they shall be even in colour, well dyed through, and free from stains; in addition to this they must possess the requisite degree of fastness to various influences, according to the special purposes for which the dyed goods are intended.

The dyeing of an even or level colour depends in the first instance upon the nature of the colouring matter itself, and secondly upon the manner in which the dyeing process is carried out, that is, upon the working conditions.

With respect to the different kinds of irregularities met with, the following may be cited:

1. Dye-spots, i. e. deeply dyed spots or specks occurring in the goods, and due to the colouring matter itself.
2. Cloudiness, dark and light, transverse or longitudinal streaks, dark lists in piece-goods, threads of unequal colour in yarn, and pieces with the centre of the cloth paler in colour than the surface, i. e. not well dyed **through.**
3. The goods appear speckled or 'seedy', i. e. each individual wool-fibre is irregularly dyed, the roots of the wool-fibres are darker in colour, the tips lighter, or in compound colours they may even be of two different shades.

The first two kinds of irregularity, if not caused by defective scouring and washing of the material, may be avoided by adopting a more suitable method of working, even when they are primarily due to the nature of the colouring matters employed. — The third mentioned defect is entirely owing to the character of the colouring matter itself; it may be lessened by altering the mode of working but it cannot always be entirely removed, hence for many kinds of material, especially piece-goods, in which, by reason of the structure of the cloth or the kind of wool employed, this defect is intensified, the use of such dyestuffs must be abandoned.

Dye-spots are most liable to occur, when the colour-acid of the dyestuff employed is either sparingly soluble or insoluble, and when it tends to become resinous or tarry in the hot dye-liquor, thus forming sticky globules which adhere to the wool.

This defect may be avoided in most cases by carefully dissolving the colouring matter in pure boiling water (if possible condensed water), then filtering, and gradually pouring the solution into the dyebath through a funnel which dips into the liquor. — Such colouring matters should never be dissolved in a little of the acid dye-liquor, and on no account should they ever be added to the dyebath itself in powder form, for under these circumstances the particles of colouring matter are apt to cake together very readily and adhere to the material; hence it is, that with all such dyestuffs, the great aim should be to cause the colour-acid to be precipitated in as fine a state of subdivision as possible, and in very dilute solution, throughout the whole dye-liquor, so that the particles remain separate and only gradually dissolve in the dye-liquor. — A modification of the normal method of working, which may be strongly recommended for colouring matters of this kind, is that in which the goods are first boiled with the dyestuff alone, or with the sole addition of Glauber's salt, and after boiling $^1/_4$—$^1/_2$ hr., adding the necessary sulphuric acid or bisulphate of soda, either all at once or gradually, in small portions at a time; in this manner the precipitation of the colour-acid with the accompanying spotting is avoided in the most certain manner. The following dyestuffs show a

tendency to produce spotting, and with these more particularly the foregoing precautions are to be observed: the different marks of **Soluble Blue, Bleu de Lyon, Alkaline Blue, Acid Violet N, 5BF, 7BN, 6BIN, R conc., 3RA, Fast Blue, Black Blue, Black Black,** and the various marks of **Fast Acid Violet;** also the following, though with these the defect is less marked: **Azo Acid Magenta G and B,** the **J-marks** of **Patent Blue, Patent Blue A, A J1, B, Azo Yellow,** etc. Most of these colouring matters give level shades on boiling, and do not otherwise produce irregularities, such as, cloudiness, or streaks due to folds in the cloth.

With the above mentioned colouring matters there is one cause of spotting which it is well to notice specially: when namely, in employing a fresh bath, the latter is charged at the **ordinary temperature** with Glauber's salt, sulphuric acid, and colour-solution, even though the latter is carefully and properly prepared the colour-acid is nevertheless precipitated; when the goods are entered and the bath is gradually heated to the boil, it sometimes happens that the minute bubbles of carbonic acid, expelled from the water, carry the particles of colour-acid to the surface, where they agglomerate as a sticky scum which produces dye-spots on the goods. If however, after charging the bath with Glauber's salt and sulphuric acid, **it is heated to the boil, and only then the colour solution is added,** the goods being also entered at the boil, no spotting in produced, since the carbonic acid has already been expelled, and cannot therefore give rise to the conditions just referred to.

Cloudiness, longitudinal and transverse stripiness due to folds, as well as imperfect penetration of the dye, all these occur, — apart from imperfect scouring or other preparation, insufficient handling, or faulty construction of the dye-vat, — whenever the wool attracts or absorbs the colouring matter too rapidly and therefore unequally, and the conditions are not conducive to an equalising of the excess and deficiency of dyestuff as they exist in the different parts of the fabric. — This tendency to rush on to the fibre exhibited by certain colouring matters, and the absence of all signs of the light and dark parts of the dyed fabric subsequently becoming obliterated, is due in the first place to the chemical nature or constitution of the colouring matters themselves. When namely the affinity of a particular colour-acid for the wool is very great, it at once unites with that portion of the material with which it first comes in contact, and there becomes so firmly fixed, that no subsequent dispersion of it takes place.

The following circumstances favour level dyeing:

1. Old dye-liquors, i. e. baths which have been already used several times for dyeing. It is an acknowledged fact which has been proved again and again in practice, that it is possible to obtain much more level colours in old dye-liquors than in fresh ones, although the cause of it has not yet been satisfactorily explained. It is no doubt probable, that the accumulation of Glauber's salt in old baths has considerable influence in the matter, and promotes level dyeing, but in addition to this, it would appear as if there were other influences at work, which are at present unknown.

2. An increased amount of Glauber's salt. The Glauber's salt employed when dyeing in an acid bath, performs a very important function; it regulates the equal distribution and absorption of the colouring matters, by moderating the action of the sulphuric acid; this last assistant is employed in order to liberate the colour-acid, thus to induce and increase its attraction by the fibre, but the simultaneous addition of the Glauber's salt causes a portion of the colouring matter to remain in the bath, and so retards its absorption. Moreover it exercises a solvent action on the particles of colouring matter which have already become fixed, it abstracts them from those parts of the wool which in the beginning took up too much colouring matter, and this being now returned to the bath, an opportunity is thus afforded to those portions which at first attracted too little colouring matter, of taking up the excess

removed from the darker portions. — An increased amount of Glauber's salt is employed when dyeing pale shades, and when using fresh dye-liquors or such colouring matters as dye level shades with difficulty; further, in the case of thick, closely woven, or heavily milled goods in order to dye them well through; and indeed whenever the dye appears irregular, it may be usefully employed as an after-addition.

3. Reduction in the amount of acid; the use of weaker acids. The sulphuric acid employed, liberates the colour-acid of the colouring matter, in which it is combined with soda or lime, and thus permits the attraction of the dyestuff, i. e. the union of the colour-acid with the wool. This takes place all the more rapidly, the more completely the colour-acid has been set at liberty, and on the other hand more slowly if the bath is less acid. If the dyeing is being carried out with colouring matters which have a great affinity for the wool-fibre, so that the latter readily dyes unevenly, one ought to diminish the amount of sulphuric acid and instead of 4 %, one should use only 3 % or 2 %, or instead of this, weaker acids such as hydrochloric, oxalic, or acetic acid should be employed. — Another method frequently adopted, is to add the acids to the bath gradually, and in small portions at a time, so that the colour-acids are liberated and attracted by the wool, by degrees. — Or again, with many colouring matters a portion only of the sulphuric acid is used at first, the remaining portion being added afterwards; or in the beginning, a weak acid like acetic acid is added, and only afterwards the stronger acid. Another method, employed in the case of many colouring matters, is to cause the necessary acid to be gradually generated in the bath itself, namely by using acetate, oxalate, or sulphate of ammonia; these salts gradually decompose during the boiling of their solutions, with evolution of ammonia, and thus acid is slowly liberated in the bath, and causes the colouring matter to be taken up by the wool.

4. Entering the goods at a low temperature. The union between the colouring matter and the wool-fibre takes place more rapidly, the higher the temperature of the dyebath, even up to the boiling point; hence, with colouring matters showing a tendency to produce uneven dyes, the goods are entered at a medium temperature, or even cold, and the bath is heated to the boiling point gradually, the dyeing process being completed by continuing to boil as long as may be necessary. — By this gradual raising of the temperature of the bath, the affinity between the fibre and the colouring matter comes into play only by degrees, so that all parts of the fabric have, as it were, an equal chance of attracting dyestuff. Nevertheless there are colouring matters, with which these measures of precaution are useless; for example, **Victoria Violet 4 BS** and **8 BS, Azo Acid Blue B, Azo Acid Black G, B, R, Azo Yellow conc.**, dye much more level shades, if the goods are at once entered into the boiling bath, continuing to boil until the dyeing is completed.

The larger the quantity of colouring matter presented to the fibre, i. e. the fuller or deeper the shade required, the more likely is it that all parts of the fabric will be equally and evenly dyed: pale fancy shades are consequently more difficult to obtain level, than medium and dark shades, because not only is the amount of colouring matter presented to the fibre comparatively small, but it is almost always necessary to make further small additions of dyestuff to the boiling bath. In the case of dark shades therefore, it is quite possible to use even those colouring matters which tend to dye unevenly; but if additions to the bath have to be made at the boil, for the purpose of matching, and when dyeing pale fancy shades, it is imperative to employ only those dyestuffs which give level colours without any difficulty.

Other circumstances and conditions of working being equal, the tendency to dye level shades depends upon the nature of the colouring matter itself, hence some acid-colours may be spoken of as 'level-dyeing-colours' while others cannot be referred to as such, and according

to their special capabilities in this respect, dyestuffs may be classified in the following groups, although these are not separated from each other by any sharp lines of division.

A. Colouring matters which give satisfactory dyes on all classes of materials.

1. The following dye perfectly level colours in a freshly made bath: if added at the boil, and in the most delicate fancy shades:

   Cyanine B; Patent-Blue V, N, superior, the various J-brands, B; Ketone Blue 4 B N; Acid Violet N; Fast Acid Violet A 2 R; Naphthol Yellow S; Wool Grey G, R, B.

2. The following dye level colours in old baths: on all classes of goods, in delicate fancy shades, even when added at the boil for matching purposes:

   Azo Yellow; Victoria Yellow; Orange Nr. 4; Orange G; Orange Nr. 2; Brilliant Orange G and O; Archil substitute G; Chromotrope 2R, 2B; Azo Acid Magenta G, B; Fast Acid Violet R, B; Patent Green O, V; Indigo substitute B, BS; Patent-Blue A, A J.

3. The following may be employed for medium and dark shades, and may be added at the boil for shading purposes:

   Acid Magenta (various marks); **Acid Violet 4 RS, 3 RS, 3 R A, R conc., 5 BF, 6 BIN, 7 BN; Acid Green** (various marks); **Brilliant Orange R; Scarlet GG to 4 R; Azo Acid Black; Azo Acid Blue; Victoria Violet; Chromotrope 6 B.**

4. The following may be used for dark shades, entering at a low temperature, and employing weak acids or large quantities of Glauber's salt:

   Victoria Scarlet (various marks); **New Coccin O; Scarlet 6 R; Scarlet 6 R crystals; Amaranth** (various marks); **Victoria Rubine** (various marks); **Naphthol Red O; Brilliant crimson; Claret Red** (various marks); **Fast Red O, S, SE; Chromotrope 8 B and 10 B; Scarlet B extra; Scarlet 5 R.**

B. Colouring matters which give speckled dyes on certain goods.

1. The following may be used for dark shades, and for matching purposes even when added at the boil:

   Fast Blue (various marks); **Black Blue O; Black Black O.**

2. The following may be used even for pale shades by employing weak acids (acetic acid):

   Fast Acid Blue R; Acid Rosamine O.

3. The following must be applied with care (using weak acids, entering at a low temperature, and adding the acid gradually):

   Soluble Blue (various marks); **Bleu de Lyon; Opal Blue; Cotton Blue** (various marks); **Fast Claret Red; Cloth Red O; Azo Black; Naphthol Black D.**

IV. The Dyeing in Alkaline Bath, with subsequent development in Acid.

The method of dyeing in an alkaline bath followed by a treatment with acid is adopted in the case of the **Alkaline Blues**; in reality it is merely a modification of the process of dyeing in an acid bath. The colour-acids of the Alkaline Blues are insoluble in acidified water and have such a great affinity for the wool-fibre that they combine with the wool even in an alkaline bath. The required colour is however only developed when the wool, after washing with water, is passed into a dilute solution of acid, whereby the colour-acids are liberated within the wool-fibre and appear with their full bright colour. The usual method is, to dye at the boil for $^3/_4$—1 hr. with the addition of 5—10 % borax, then to wash thoroughly, and finally to pass the material into another bath containing 5 % sulphuric acid. The lower the temperature of the developing bath, the greener is the shade of blue obtained; if the temperature is raised the shades become redder in tone. — With the object of increasing the fastness of the dyes towards milling, the bath is sometimes acidified with alum, or stannic chloride and tartaric acid. The only disadvantage of dyeing in an alkaline bath is that piece-goods, particularly certain kind of worsteds, readily become brittle. — The dyes obtained with the Alkali Colours, when well washed, are fairly fast to rubbing, satisfactorily fast to light, fast to acid and to sulphur-stoving, they are of remarkable brilliancy, but are not fast to alkalis.

V. The Dyeing in Acid Bath and developing with Metallic Salts.

This method was devised and published in 1889 by the Hoechst firm (Farbwerk vormals Meister, Lucius und Brüning) first of all in connection with the **Chromotrope Colours,** but it was afterwards found to be of practical use in the case of several other colouring matters, for which its employment is patented, e. g. **Chromotrope S, FB**; **Chromogen I, Chrome Brown RO, BO**; and all the various **Acid Alizarin Colours**. — The principle of this method is based upon the fact, that the foregoing dyestuffs are attracted and taken up by the wool in an acid bath, and by subsequently treating the dyed wool with bichromate of potash or soda, alum, or fluoride of chromium, they are changed on the fibre itself into insoluble, dark coloured, and very fast compounds. In the case of Chromogen I, Chrome Brown RO, BO, Chromotrope S and FB, this treatment of the dyed fibre with bichromate is one of oxidation; in the case of the Acid Alizarin Colours, Alizarin Yellow GGW, RW, Mordant Yellow O, and certain Chromotropes (2 B, 8 B, 10 B), it is a process of lake-formation whatever metallic salt be employed. — The first part of this method is carried out in the same manner as when dyeing in acid bath, the special details being varied to suit the different level-dyeing properties of the several colouring matters.

The following readily dye level colours in a boiling bath:

Chromogen I, Alizarin Yellow GGW, RW, Mordant Yellow O, Alizarin 1WS to 5WS, Acid Alizarin Blue BB and Chromotrope 2 B, Alizarin Orange G, N paste and powder.

The following dye level colours with a little more difficulty than the above:

Chromotrope FB, Chrome Brown RO, Acid Alizarin Green G, Acid Alizarin Blue GR, Chromotrope 8 B and 10 B.

The following only dye level colours with difficulty:

Chromotrope S, SB, SR.

The operation of developing may take place in the same or in a separate bath; the question as to which of these methods is to be adopted chiefly depends upon whether one intends to use the baths for further lots of material, or not; if the former the first method is employed, if the latter the single bath method is used, making up a fresh bath for each lot of material to be dyed. — Both methods have their advantages and disadvantages. In the single-bath method the quality of the goods remains unimpaired and there is a saving of time, but in the case of certain colouring matters the dyes obtained are apt to rub-off and to be speckled in appearance, because that portion of the colouring matter which is not taken up by the fibre in the acid bath, is precipitated in the bath itself by the addition of the metallic salt as a lake, and this is fixed upon the fibre more or less superficially and not in intimate union with it. The **two-bath method** has the advantage, that the baths can be used again and again for further lots of material, and the colours obtained are therefore more level, better dyed through, and not apt to rub-off, but of course the time required for entering and removing the goods with each bath is greater. — As already stated, the action which takes place in this method of dyeing is either one of oxidation or of lake-formation; some colouring matters can only be developed by means of bichromate of potash or soda, while others which are destroyed by oxidation, must be developed with alum or fluoride of chromium.

According to the method of development employed the colouring matters under consideration may be classified as follows:

I. Developed only with bichromate of potash or soda:

Chromogen I, Chrome Brown RO and BO, Chromotrope FB, S, SB, SR.

II. Developed with fluoride of chromium:

Acid Alizarin Blue BB, GR; Victoria Violet 4BS, 8BS; Azo Acid Blue B. If developed with bichrome these colours are destroyed.

III. Developed with alum:

Alizarin 1WS, 2WS, 3WS, 4WS, 5WS; Alizarin Orange N, G; Alizarin Yellow GGW; Acid Alizarin Blue BB.

IV. Developed with bichromate of potash or fluoride of chromium:

Acid Alizarin Green G; Alizarin Red 1WS—5WS, Alizarin Orange N, G; Alizarin Yellow GGW, RW; Mordant Yellow O; Chromotrope 8B, 10B, 2B, (the last mentioned is almost invariably developed with bichrome).

The colouring matters of Groups I and II cannot be employed together, whereas those of Group IV can be associated either with those of Group I or Group II.

After the addition of the developer, the baths containing the above colouring matters are, generally speaking, not useful for shading purposes; for dark colours, and on goods which present no difficulty in dyeing level shades, the following dyestuffs may be added to the dyebath for shading purposes, if due care be exercised: **Chromotrope 2B, Chromotrope FB, Alizarin Red WS** (various marks), **Alizarin Yellow GGW and RW, Acid Alizarin Blue BB;** nevertheless it is best, when shading at the boil, to employ level-dyeing acid colouring matters.

The following colouring matters may be used for shading purposes after development with bichromate of potash:

Patent Blue V, N, superior, A, B, J (various marks); **Acid Violet N, 5 BF; Fast Acid Red A; Fast Acid Violet R, A 2 R; Orange G, No. 2; Brilliant Orange G, O; Azo Yellow; Victoria Yellow; Orange No. 4.**

The following colours should not be used for this purpose:

Fast Acid Blue R; Fast Acid Violet B; Azo Acid Magenta G, B; Chromotrope 2 R, 6 B; Victoria Violet 4 BS, 8 BS; Azo Acid Blue B; Azo Acid Black.

For the purpose of shading after development with fluoride of chromium or alum all acid-colours are suitable, except those with tend to give uneven dyes by reason of lake-formation, e. g. **Chromotrope; Azo Acid Magenta; Victoria Violet; Azo Acid Blue; and Azo Acid Black.**

VI. The Dyeing on Mordanted Wool.

This method, which is of the greatest importance for dyeing fast colours on wool, is chiefly employed in the case of the alizarin-colours and certain azo-colours. The principle of the process is based upon the following two facts: first, the property possessed by wool of decomposing metallic salts when boiled in their dilute solutions, and attracting to itself the metallic oxides in the form of very basic salts, and second, the property of the mordant-dyestuffs of combining with these metallic oxides to form insoluble coloured salts — lakes —, when the wool charged with metallic oxide, or — mordanted — as it is termed, is brought into the dyebath under suitable conditions. Accordingly in this method of dyeing we have to distinguish between the two operations of — mordanting — and — dyeing.

The mordanting of wool.

With the coal-tar colours this operation is carried out either with alum mordant or with chrome mordant. The alum mordant is almost entirely used for red shades, whereas the chrome mordant is very largely employed previous to dyeing with all alizarin-colours. — When mordanting wool with alum, an operation which is sometimes called 'preparing', the bath is charged with

5 % Tartar and
8 % Alum.

The carefully scoured goods are then introduced, and while they are being continually moved about in the solution, the latter is gradually heated to the boiling point, and boiled for about 1 1/2 hrs. The quantity of liquor in the bath should not be more than 50 nor less than 30 times the weight of the wool. With too much liquor the alum mordant is insufficiently fixed, alumina being precipitated even in the mordant bath itself and then becoming superficially fixed upon the wool, so that the colours ultimately obtained are poor, bare, and devoid of brilliancy, and have the defect of rubbing-off. If on the other hand the bath contains too little liquor, so that the mordant solution is too concentrated, there is fixed on the wool along with the alumina too much acid, and this hinders the formation of the colour-lake during the dyeing process, with the result that the dyes obtained are not so fast and are usually of an orange shade. — It is a matter of special importance to ascertain that neither the water nor the alum employed contain any iron, because the presence even of very small quantities of iron suffices to dull the red. — The addition of the tartar prevents the too rapid decom-

position of the alum, so that the alumina is kept longer in solution, and a better penetration of the fibre by the mordant is thus ensured. Instead of tartar alone, one may use a mixture of tartar and oxalic acid, or even oxalic acid alone.

The chrome mordant is much more frequently employed than alum, in preparing wool for the application of the mordant dyestuffs. As a rule bichromate of potash and tartar are employed, since for most colouring matters this mixture gives the best results. The mordanting bath is charged with:

4 % bichrome	for dark	3 % bichrome	for medium	1 % bichrome	for pale
3 % tartar	shades,	$2\frac{1}{2}$ % tartar	shades,	1 % tartar	shades.

The proportions usually employed are 3 % bichrome and $2\frac{1}{2}$ % tartar. In the case of hard water a further addition of 5—10 % acetic acid 12° Tw. must be made, by way of correcting the carbonate of lime in the water, otherwise the tartar is neutralised, its action is interfered with, and the wool is insufficiently mordanted. After boiling for $1\frac{1}{2}$—2 hrs., the goods are removed from the mordanting bath and then preferably left lying over-night, before washing and dyeing. — Piece-goods and yarn should be well washed after mordanting, and should never be allowed to hang over-night on poles or rails, otherwise inequalities in the dye are readily produced. — In this process of mordanting, the wool takes up chromic acid from the bichromate of potash, but by the continued boiling and under the reducing action of the tartar and of the wool itself, it is reduced to chromic hydrate; by allowing the material to lie in the mordanted condition over-night this reducing process continues and is rendered more complete. — Wool properly mordanted with bichrome and tartar should have a pale greenish colour, not a brownish or yellowish colour. In the interval between mordanting and dyeing the goods should be kept in the moist condition, and protected from the direct action of sun-light, otherwise uneven colours result, since in the dried and exposed parts any remaining chromic acid is reduced, and the mordant in these portions is strengthened. — Instead of tartar, other assistants may be employed, for example oxalic acid, and particularly sulphuric acid. This substitution of the tartar is not to be recommended in the case of some colouring matters, such as **Ceruleïn** and **Alizarin Blue,** which are sensitive to the action of chromic acid and therefore give duller colours on all mordants containing this constituent to any considerable extent; on the other hand the bichrome and sulphuric acid mordant, first recommended by the Hœchst Farbwerke, may be advantageously employed for **Alizarin Red, Alizarin Orange, Alizarin GGW** and **RW,** and **Mordant Yellow,** because the fastness to milling of the dyes they yield, is materially increased by the sulphuric acid. — It is customary to mordant with

3 % bichrome	for medium colours,	4 % bichrome	for dark colours.
1 % sulphuric acid		1,5 % sulphuric acid	

It is not desirable to employ the bichrome and sulphuric acid mordant for pale shades. For the rest, this method is carried out in the same manner as already described for the bichrome and tartar mordant. In the case of hard water the amount of sulphuric acid must be increased by 0,5—1,5 % according to the hardness of the water. When mordanting with bichrome and sulphuric acid, the chromic acid which is liberated, is attracted and fixed by the wool, on boiling however, a portion is reduced by the wool-fibre to chromic hydrate, but since no other reducing agent is present, there is, even at the end o the mordanting process, always some chromic acid left on the wool unreduced, and it is probably present in combination with the chromic hydrate as chromate of chromium. This mordant seems to fix the above mentioned colouring matters better than if the wool contained chromic hydrate with little or no chromic acid, as when bichrome and tartar are employed, for they do not 'bleed' during milling. — Instead of bichromate of potash one may also employ an

equal weight of bichromate of soda for mordanting wool. Substitutes for tartar are frequently sold under a variety of names, but their employment is not to be recommended. — For combinations of **Alizarin Red** and **Alizarin Orange** with **Logwood** and **Old Fustic**, and also for the purpose of rendering the dyes faster to milling and light, the bichrome and sulphuric acid mordant is often replaced with bichrome, copper sulphate and sulphuric acid.

In recent years another mordant recommended for mordant-dyestuffs instead of bichrome is 4% fluoride of chromium and 1% oxalic acid. When this is employed the chromium is fixed upon the fibre entirely in the form of chromic oxide; this has the advantage that pale shades appear to be faster to light with fluoride of chromium than on the bichrome and tartar mordant. — When bichrome is employed, even when tartar is used in addition, and the boiling is long continued, the wool invariably still contains a little unreduced chromic acid, which does not completely disappear even after dyeing, milling, washing, etc., but which under the influence of light acts upon the colours and causes them to fade more quickly, than can be accounted for by the action of light alone, in the absence of chromic acid. — For fancy shades therefore, dyed with alizarin-colours, the fluoride of chromium mordant may be highly recommended, because it entirely avoids any occurence of this unfavourable action of the chromic acid.

The Dyeing of Wool.

The following colouring matters are dyed on alum mordant: **Alizarin Red paste** (various marks); **Alizarin Red WS powder**; **Alizarin Orange N, G**; **Alizarin Claret R**, and occasionally **Alizarin Yellow GGW** and **RW**. — To obtain a good fast red the presence of lime, preferably as acetate of lime, is absolutely necessary. The bath is charged with dyestuff, which is first mixed with water and then passed through a sieve, then there is added

7,5% Acetate of lime, 2% Tannin } for dark shades, 5% Acetate of lime, 1% Tannin } for medium shades,

2,5% Acetate of lime, 0,5% Tannin } for pale shades.

The goods are entered at the ordinary temperature, which is then gradually raised in the course of an hour to the boiling point, the goods being handled continually; after boiling 1—1½ hrs., they are washed and dried. — The addition of tannic acid greatly increases the fastness of the dye towards milling, especially as regards bleeding, and was first recommended for Alizarin Red on alum mordant by the Hœchst Colour-Works in 1887. — To ensure bright colours on alum mordant, it is important that the dye-liquor should be free from iron compounds, since these dull the shade. — As a rule, it is not necessary to correct a calcareous water with acetic acid when alum mordant is employed, because the mordant itself is strongly acid, and an excess of acid hinders the formation of the colour-lake; only in the case of the W S marks, and with very hard water, is a small addition of acetic acid sometimes necessary.

On chromium mordant it is customary to dye with all the various mordant-colours given in the tables, and indeed frequently in combination with dye-woods. — The bichrome and tartar mordant is specially suitable for **Alizarin Blue, Ceruleïn,** and for most fancy shades, but for the various marks of **Alizarin Orange, Alizarin Red, and Alizarin Yellow,** and for all compound shades where these colouring matters are largely used, the bichrome and sulphuric acid mordant may be employed.

In the dyebath the mordant-colours combine with the chromic hydrate fixed on the mordanted wool; in a hot dye liquor this combination takes place very rapidly, but in the cold, the formation of colour-lake proceeds slowly and invariably remains incomplete. If therefore level shades are to be obtained with mordant-colours, it is almost always advisable to enter the goods into the bath at a low temperature, and with continual handling, the temperature is then slowly and regularly raised to the boiling point, the formation of the colour-lake being only completed towards the end of the dyeing process by continued boiling. — If the goods are entered at too high a temperature, and the bath is heated up too rapidly or irregularly, the result is that some portions of the material attract more colouring matter than others, and the goods remain permanently uneven. So firmly are the colour-lakes fixed upon the fibre, that even by long continued boiling it is not possibly, as a rule, to equalise the colour. — Apart from regulating the temperature of the dyebath, as stated above, one may also retard the dyeing process in the case of mordant-colours by the addition of alkalis to the bath; these form soluble salts with the colour-acids, which remain in the dyebath even at the boil to a certain extent, giving up the colouring matter to the fibre gradually and always incompletely; only when acetic acid is added, so as to liberate the colour-acids, are the latter taken up by the mordanted wool. — This method is adopted when dyeing piece-goods which are difficult to dye through, also hat-felt, and slubbing in dyeing-machines, especially in the case of pale shades: — The dye-bath is charged with colouring matter and 2—3% ammonia, the goods are then entered, the temperature is raised to the boil, and acetic acid is gradually added; in this manner an equal penetration of the material with dyestuff is attained, they are dyed through better, and the shades are more level. — It is well to remark that for this method of working the water should be as free from lime as possible, otherwise a serious loss of colouring matter may result, and the occurrence of precipitates in the bath may defeat the object in view.

The condition of the water used in dyeing plays an important part when dyeing with the mordant-colours. Any lime and magnesia in the water, especially if present as bicarbonates, act on many colouring-matters by precipitating them as calcium or magnesium lakes, so that they are only partially taken up by the fibre. — Further, organic impurities act very injuriously upon many colouring matters (especially Alizarin Blue) and prevent their fixation. — Finally, the presence of any iron in the water has a detrimental influence, even when dyeing on chrome mordant, although not to the same extent as when alum mordant is used.

Water which is highly charged with lime, magnesia, or iron, or even with organic impurities, ought, if intended for alizarin dyeing, to be treated in a water purifying apparatus. In any case such water should be corrected by making a suitable addition of acetic acid.

On chrome mordant all **Alizarin** and **Mordant-Colours** are dyed with an addition of acetic acid. The object of this addition is three-fold:

1. In the first case it corrects the water and changes the carbonates of lime and magnesia into acetates, thus preventing or retarding any lake formation or precipitation in the bath, so injurious for the fixing of the colouring matter on the fibre. This addition of acetic acid is necessary with all **mordant-colours**, and amounts to 200 cubic centimetres of acetic acid 12° Tw. for each cubic metre of water, if the latter has a hardness of 5°, and 400 cc. if the hardness is 10°; it is best however to find exactly what amount is necessary by making a special alkalimetric determination. (See the Table for finding the amount of acetic acid to correct water on p. 73.)

2. Another reason for the addition of the acetic acid is that it neutralises the alkali present in many dyestuffs. Certain series of colouring matters are the sodium salts of

colour-acids, and these necessitate the addition of an excess of acetic acid beyond what is required to correct the water, in order to liberate the corresponding colour-acids: such, for example, are: **Alizarin Red powder, Alizarin Red 1 W S—5 W S, Alizarin Orange N powder, Alizarin Brown powder, Alizarin Blue D N W, Alizarin Yellow G G W and R W powder, and Galleïn W powder.** The excess of acetic acid at 12° Tw. to be added to the dyebath amounts to 750 cc. per kilogram of the dyestuffs in powder form, and 150 cc. per kilo of **Alizarin Blue D N W.**

3. With other series of colouring matters the addition of an excess of acetic acid is necessary because it facilitates their attraction by, and fixation on, the mordanted fibre, e. g. **Alizarin Blue and Ceruleïn** (various marks), **Alizarin Black P and S, Alizarin Green S, Alizarin Yellow G G W and R W either in paste or powder form, and Mordant Yellow O.** Experiment has shown that for this purpose the excess of acetic acid 12° Tw. reckoned on the weight of wool, amounts to 2 %, and is an addition over and above that required for correcting the water and neutralising the alkali of the dyestuffs referred to in the preceding paragraph. — On the other hand the following colours require as neutral a bath as possible, since excess of acetic acid causes the bath to be less exhausted, and the colour to be less completely fixed upon the fibre: **Alizarin Red, Alizarin Orange, Alizarin Brown, and Galleïn** (various marks of each colour). In cases where compound shades are dyed, for which colouring matters belonging to each of the two series just named are required, it is as a rule desirable to dye with the addition of an excess of acetic acid, except with very pale colours for which the amount of acetic acid employed should be as little as possible.

When charging the dyebath, the necessary amount of acetic acid is first added, (in accordance with what has been said in the preceding paragraphs numbered 1, 2, 3), the paste colours are then well mixed with about 10 times their weight of cold condensed water, or corrected water from the dyebath, and the mixture is poured into the bath through a fine hair or brass-wire sieve; the colours in powder form are as a rule dissolved in boiling water, and the solution is added to the bath, but for **Ceruleïn S, Alizarin Green S, and Alizarin Black S,** only tepid water should be used. — The goods are entered at a temperature of about 30—35° C. (85—95° F.), worked for 1/4 hr. without heating, and then the temperature is gradually raised, so that the bath comes to the boil in the course of 3/4—1 hr.; after boiling 1 1/2—2 1/2 hrs. the process is complete. — For heavy piece-goods difficult to dye through, for hat-felt, and also when employing dyeing machines, the process with the use of ammonia as given above, is adopted. In this case the dyeing may be begun even with hot solutions, and the spent dye-liquors may be used for further lots of material by neutralising the acetic acid with ammonia until the liquor is slightly alkaline, and then freshening up with additional colour-solution. — In all cases of dyeing with mordant-colours it is best to add at the very beginning the full quantity of dyestuff required; if however it should become necessary to make a further addition of dyestuff at the boil, a portion of the bath is run off, and cooled down to 50—60° C. (120—140° F.) with cold water, then the dyestuff is added, the bath is raised again to the boil, and boiled 3/4—1 hr. — With full dark shades, which contain a large proportion of Alizarin Brown, Alizarin Red, Alizarin Orange, or Alizarin Yellow G G W, in order to make the colours faster to milling, it is desirable, after 1—1 1/2 hrs. boiling, to sadden in the same bath with 1/2 % bichromate of potash or 1 % sulphate of copper, and to continue the boiling for 1/2 hr. longer.

The mordant-colours can be used together, or with the dyewoods, and they can also be shaded with the faster acid-colours, particularly Patent Blue A, the various Fast Acid Violets, and Fast Acid Blue.

Further details regarding the employment of the mordant-colours in the different branches of the woollen industry are reserved for Part II of this work.

Table for determining the amount of Acetic acid required to correct hard water employed in dyeing.

One litre of water is tinted with a trace of Methyl Orange and then $^1/_{10}$ normal hydrochloric acid (10 cc. hydrochloric acid 34.2° Tw. per litre water) is run in from a burette until it is decolourised. The numbers of cc. acid used are then found in the first column of the following table, and in the same horizontal line are given the amounts of acetic acid of various degrees Twaddell required to correct 100 litres of the water.

Number of cc. $^1/_{10}$ normal acid required per litre water.	Number of grams Acetic acid, 2.8 to 12° Tw., required per 100 litres water.							Number of cc. $^1/_{10}$ normal acid required per litre water.	Number of grams Acetic acid, 2·8 to 12° Tw., required per 100 litres water.						
	12°	10.4°	8.8°	7.2°	5.8°	4.4°	2.8°		12°	10.4°	8.8°	7.2°	5.8°	4.4°	2.8°
1	1,3	1,5	2	2,4	3	3,5	6	51	66,3	76,5	102	122,4	153	178,5	306
2	2,6	3	4	4,8	6	7	12	52	67,6	78	104	124,8	156	182	312
3	3,9	4,5	6	7,2	9	10,5	18	53	68,9	79,5	106	127,2	159	185,5	318
4	5,2	6	8	9,6	12	14	24	54	70,2	81	108	129,6	162	189	324
5	6,5	7,5	10	12	15	17,5	30	55	71,5	82,5	110	132	165	192,5	330
6	7,8	9	12	14,4	18	21	36	56	72,8	84	112	134,4	168	196	336
7	9,1	10,5	14	16,8	21	24,5	42	57	74,1	85,5	114	136,8	171	199,5	342
8	10,4	12	16	19,2	24	28	48	58	75,4	87	116	139,2	174	203	348
9	11,7	13,5	18	21,6	27	31,5	54	59	76,7	88,5	118	141,6	177	206,5	354
10	13	15	20	24	30	35	60	60	78	90	120	144	180	210	360
11	14,3	16,5	22	26,4	33	38,5	66	61	79,3	91,5	122	146,4	183	213,5	366
12	15,6	18	24	28,8	36	42	72	62	80,6	93	124	148,8	186	217	372
13	16,9	19,5	26	31,2	39	45,5	78	63	81,9	94,5	126	151,2	189	220,5	378
14	18,2	21	28	33,6	42	49	84	64	83,2	96	128	153,6	192	224	384
15	19,5	22,5	30	36	45	52,5	90	65	84,5	97,5	130	156	195	227,5	390
16	20,8	24	32	38,4	48	56	96	66	85,8	99	132	158,4	198	231	396
17	22,1	25,5	34	40,8	51	59,5	102	67	87,1	100,5	134	160 8	201	234,5	402
18	23,4	27	·36	43,2	54	63	108	68	88,4	102	136	163,2	204	238	408
19	24,7	28,5	38	45,6	57	66,5	114	69	89,7	103,5	138	165,6	207	241,5	414
20	26	30	40	48	60	70	120	70	91	105	140	168	210	245	420
21	27,3	31,5	42	50,4	63	73,5	126	71	92,3	106,5	142	170,4	213	248,5	426
22	28,6	33	44	52,8	66	77	132	72	93,6	108	144	172,8	216	252	432
23	29,9	34,5	46	55,2	69	80,5	138	73	94,9	109,5	146	175,2	219	255,5	438
24	31,2	36	48	57,6	72	84	144	74	96,2	111	148	177,6	222	259	444
25	32,5	37,5	50	60	75	87,5	150	75	97,5	112,5	150	180	225	262,5	450
26	33,8	39	52	62,4	78	91	156	76	98,8	114	152	182,4	228	266	456
27	35,1	40,5	54	64,8	81	94,5	162	77	100,1	115,5	154	184,8	231	269,5	462
28	36,4	42	56	67,2	84	98	168	78	101,4	117	156	187,2	234	273	468
29	37,7	43,5	58	69,6	87	101,5	174	79	102,7	118,5	158	189,6	237	276,5	474
30	39	45	60	72	90	105	180	80	104	120	160	192	240	280	480
31	40,3	46,5	62	74,4	93	108,5	186	81	105,3	121,5	162	194,4	243	283,5	486
32	41,6	48	64	76,8	96	112	192	82	106,6	123	164	196,8	246	287	492
33	42,9	49,5	66	79,2	99	115,5	198	83	107,9	124,5	166	199,2	249	290,5	498
34	44,2	51	68	81,6	102	119	204	84	109,2	126	168	201,6	252	294	504
35	45,5	52,5	70	84	105	122,5	210	85	110,5	127,5	170	204	255	297,5	510
36	46,8	54	72	86,4	108	126	216	86	111,8	129	172	206,4	258	301	516
37	48,1	55,5	74	88,8	111	129,5	222	87	113,1	130,5	174	208,8	261	304,5	522
38	49,4	57	76	91,2	114	133	228	88	114,4	132	176	211,2	264	308	528
39	50,7	58,5	78	93,6	117	136,5	234	89	115,7	133,5	178	213,6	267	311,5	534
40	52	60	80	96	120	140	240	90	117	135	180	216	270	315	540
41	53,3	61,5	82	98,4	123	143,5	246	91	118,3	136,5	182	218,4	273	318,5	546
42	54,6	63	84	100,8	126	147	252	92	119,6	138	184	220,8	276	322	552
43	55,9	64,5	86	103,2	129	150,5	258	93	120,9	139,5	186	223,2	279	325,5	558
44	57,2	66	88	105,6	132	154	264	94	122,2	141	188	225,6	282	329	564
45	58,5	67,5	90	108	135	157,5	270	95	123,5	142,5	190	228	285	332,5	570
46	59,8	69	92	110,4	138	161	276	96	124,8	144	192	230,4	288	336	576
47	61,1	70,5	94	112,8	141	164,5	282	97	126,1	145,5	194	232,8	291	339,5	582
48	62,4	72	96	115,2	144	168	288	98	127,4	147	196	235,2	294	343	588
49	63,7	73,5	98	117,6	147	171,5	294	99	128,7	148,5	198	237,6	297	346,5	594
50	65	75	100	120	150	175	300	100	130	150	200	240	300	350	600

B.

General Methods of Cotton Dyeing.

Cotton is not always washed or bleached before dyeing, but from motives of economy it is dyed in the raw condition, wherever possible; a purification or cleansing of the fibre by boiling with water or by bleaching is only carried out when very delicate shades have to be dyed, or when a level colour is not otherwise obtainable; the latter condition may arise, for example, in the case of piece-goods containing size. The preliminary operations of bleaching and boiling, as they are carried out in practice, will however be treated of in the second part of this work, at least so far as they are connected with dyeing.

In the following chapters it is intended to explain the principles of the different methods of dyeing cotton which are adopted in accordance with the varied nature of the colouring matters employed:

These methods are as follows:

I. Dyeing by means of oxidation.

II. Direct dyeing of unmordanted cotton in neutral, slightly acid or slightly alkaline bath.

III. Direct dyeing with subsequent fixation.

IV. Production of Azo-Colours on the fibre itself from their constituent elements.

V. Dyeing on tannic acid and fatty-acid mordants or their respective metallic compounds.

VI. Dyeing on animalised fibre.

VII. Dyeing on simple or compound metallic mordants with or without fatty-acids.

VIII. Dyeing by single or repeated impregnation followed by steaming or drying.

I. Dyeing by means of oxidation.

This method is almost entirely confined to **Indigo Vat Blue** and **Aniline Black.**

In order to dye **Indigo Blue,** the material is first impregnated with a solution of indigo-white contained in the dye-bath, or vat as it is usually called, and after having removed

the excess of liquor from the material by squeezing, the latter is exposed to the air for some time, in order to reconvert the indigo-white into the insoluble indigo-blue, which is precipitated within and upon the fibre. By choosing a suitable concentration of the vat, and by repeating the operation, light or dark shades can be produced.

Aniline Black is an oxidation product of aniline or toluidine, but its exact constitution has not yet been determined. It is produced by the action upon the aniline of certain oxidising agents, particularly the salts of chromic or chloric acid, there being also necessary, in the case of the latter, the presence of metallic salts e. g. of aluminium, iron, copper, vanadium, etc. Three methods of dyeing Aniline Black are in vogue, viz:

a) **Single-bath Dyed Black.** A mixture of aniline and chromic salt is prepared in such a manner that the insoluble black substance is slowly formed in the solution; the material which is worked in it, gradually attracts the major portion of the precipitate and indeed for the most part mechanically.

b) **Oxidation Black.** In this method the colour is only developed after allowing the material, impregnated with the solution, to hang for some time in a warm atmosphere.

c) **Steam Black.** The development of colour in this case is effected more rapidly by means of a steaming process.

Further details respecting the composition of the necessary solutions and the order in which the various operations are to be carried out, will be given in the special part of this work.

II. Direct Dyeing.

The number of colouring matters capable of dyeing direct, i. e. without the intervention of any fixing agent, is very large, but their useful employment is limited by considerations of fastness.

If cotton is impregnated with the solution of a colouring matter, for which it has no affinity, and it is then dried without washing, the fibre certainly appears to be dyed, but by washing with cold water, and more readily with hot water, the colour can be entirely removed. On the other hand it is easy to conceive of a colouring matter which might be completely absorbed by the fibre from the solution, and which could not be removed by subsequent washing.

Between these two extremes there exists quite a large number of colouring matters possessing various degrees of affinity for the fibre. There are indeed few substances for which the cotton itself, or certain of its natural impurities, does not possess some slight affinity, so that if the fibre is worked in their solution, it usually acquires a colour which is darker than can be ascribed to a simple impregnation with the coloured solution, even though it is capable of being entirely removed by long continued washing.

At the same time there are at present no Direct Colours, which entirely exhaust the dyebath without the aid of assistants and which are also absolutely fast to washing with water. Here again the various direct-colours behave very differently in dyeing, according indeed to their general chemical properties.

Nearly all the **Basic-Colours** dye cotton to some extent when the latter is worked in a lukewarm neutral bath; a little alum is usually added to facilitate the process. The dyes thus obtained are usually very bright, but they are not fast to washing with water.

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Certain colouring matters belonging to the group of the Soluble Indulines form an exception however e. g. **Indamine Blue, Direct Blue, Anil Blue, Methylene Grey, Direct Grey,** all of which give fast dyes in the form of their free bases or as basic salts, the best results being obtained with the addition of sodium acetate to the bath.

The **Resorcin Colours** are dyed in a lukewarm bath with a large addition of common salt; the latter diminishes their solubility and thus the dyeing process depends upon the gradual salting out of the colouring matter within the fibre. The dyes obtained in this manner are also not fast.

Some of the **Acid Colours** (Fast Blue, Nigrosine) are dyed in a slightly acid bath, the sparingly soluble sulphonic acids being thereby precipitated upon the cotton.

The **Azo Colours** (as used for wool) are dyed with the simple addition of common salt, like the Eosines, or with the addition of alum, in which case advantage is taken of the slight solubility of the alumina-lakes. The colours obtained are also loose and must not be washed after dyeing. The dyebaths are never exhausted and since fairly concentrated liquors are employed, a portion of the latter is invariably dried into the fibre without in any way being fixed.

In contradistinction to the foregoing groups, the true **Direct-Colours** for cotton, which are applied in a neutral, alkaline, or occasionally a weak acid bath, give dyes which to a certain extent are fast to washing with water.

In order to promote the exhaustion of the baths, it is usual to add to them either common salt or Glauber's salt; alkaline additions (carbonate of soda or potash, phosphate of soda, soap, Turkey-red oil) are made partly for the purpose of rendering the colouring matters more soluble and thus preventing the formation of spots, and partly also to retard the exhaustion of the bath and ensure level dyeing.

III. Direct Dyeing with subsequent fixation.

In order to improve the fastness of direct-dyes and also to obtain darker shades, the dyed materials are frequently submitted to various after-treatments.

a) With colouring matters which contain free amido-groups capable of being diazotised, the dyed material may be treated with sodium nitrite and hydrochloric acid, whereby the amido-group is changed into the diazo-group, which is then capable of uniting further with phenols (e. g. Naphthol), amines (e. g. Phenylene-diamine), or their sulphonic acids, and in this manner producing new colouring matters on the material itself. Being characterised by possessing greater molecular weight, they are nearly always insoluble (consequently fast to water and to soap) and at the same time they give deeper and fuller shades.

In many cases, instead of employing the mode of development referred to, the dyed materials are simply treated with sodium carbonate, whereby the diazo-group of the colouring matter is changed into a hydroxyl-group.

b) With colouring matters capable of uniting with metallic oxides to form salts, the dyed materials may be treated with certain metallic salts, e. g. those of copper and chromium, in order to convert the colouring matter into a sparingly soluble or quite insoluble lake. By this means the shade is as a rule not much altered, but the dye is rendered much faster to washing and to alkalis.

c) In some cases useful changes are effected by submitting the dyed materials to an oxidising process, which may possibly be accompanied by lake formation; for this purpose bichromate of potash is used, either alone or in conjunction with copper salts.

IV. Production of Azo Colours on the fibre itself, from their constituent elements.

This process, the practical details of which will be fully given in Part II of this work, consists in first impregnating the fibre with a solution of the sodium salt of the phenol, (e. g. naphthol), then drying, and submitting it to the action of the diazotised base in any convenient manner. In this way the corresponding insoluble azo-colour is produced upon and within the fibre. The dyes thus obtained are characterised by special fastness to washing.

V. Dyeing on Tannic acid or Fatty-acid Mordants.

The principle of this method, which is very largely employed in practice, is as follows: the goods are treated with a solution of tannic acid or fatty-acid (e. g. Turkey-red oil, soap), which is fixed on the fibre by a treatment with some metallic salt (e. g. tartar-emetic, acetate of alumina). On these mordants one may now dye either with Basic-Colours or with their sulphonic acids, although the latter do not give such fast dyes. In order to prevent too rapid absorption of the colouring matter, an addition of acetic acid or alum is made to the dyebath; the goods are entered cold and the temperature is gradually raised to the boiling point.

VI. Dyeing on animalised fibre.

In order to render vegetable fibres capable of being dyed like wool, with Acid and Basic Colours, various methods may be adopted, nearly all of which are based upon the plan of coating the fibre with some albuminous compound (e. g. albumen, caseïn, glue), which then serves as the carrier of the colour. These methods, which are now of little more than historical interest, will be referred to in further detail in Part II of this work.

VII. Dyeing on simple or compound mordants, with or without fatty-acids.

This method is one of the greatest importance in cotton dyeing, and among the various mordants there are especially two which stand out prominently as of great practical value: the oil-alumina mordants for alizarin-red (as in Turkey-red dyeing) and the chrome mordant for other colours.

The methods of preparing and employing these mordants, as well as the various points to be noticed in connection with the dyeing process, stand in such intimate relationship, that it is impossible without some repetition, to refer here briefly to what is given in greater detail in Part II of this work. The principle of the method consists in first precipitating upon the fibre a metallic oxide, either in the form of free base (e. g. chromic hydrate), or as a basic salt (e. g. basic oleate or sulpholeate of alumina); during the dyeing process, which is begun in the cold and gradually continued up to the boil, this oxide or basic salt combines with the colouring matter to form a colour-lake, the fastness of which may be largely increased by a subsequent steaming process.

Metallic mordants are however not only employed, for the Alizarin Colours, but also for the Azo and Acid Colours. In this case alkaline metallic salts are used as a rule, e. g. aluminate of soda, stannate of soda in combination with normal salts, sulphate of alumina, stannous chloride, stannic chloride, etc.; the goods are, for example, impregnated with aluminate of soda, which is fixed by means of stannous or stannic chloride, or they are first prepared with stannate of soda and fixed with aluminium sulphate. In this way double compounds of metallic oxides are formed e. g. stannate of alumina, which to a certain extent are capable of fixing otherwise soluble colour-acids. Another method of obtaining compound mordants is that devised by H. Koechlin, in which the goods are prepared with chromic oxide or with chromium and magnesium salts, and then fixing them by means of a solution of zinc oxide in sodium hydrate, or with ammonia. When, in the second part of this work, the methods of applying the Acid and Azo Colours are explained, a number of such processes, having this object in view, will be given.

VIII. Dyeing by single or repeated impregnation followed by steaming or drying.

The following modifications of this method of dyeing may be mentioned:

a) One method is that long known to the calico-printers, which is based upon the fact that the bisulphite compounds of certain alizarin-colours, may be mixed with metallic mordants (e. g. acetates or bisulphites) without causing the precipitation of a lake; if however the material prepared with the mixture is dried and steamed, the volatile acids are driven off, and the colouring matter at once combines with the mordant, the lake thus produced becoming at the same time fixed upon the fabric.

b) The use of bisulphite compounds is confined to a few colouring matters, but the method of Erban & Specht, now to be mentioned, is capable of much wider application. This method is based upon the employment of alkaline solutions of the alizarin-colours, such solutions being chiefly made by means of a volatile alkali (ammonia).

The material to be dyed is impregnated with the alkaline colour solution and dried, whereby the volatile solvent escapes and the colouring matter is deposited in an insoluble form upon the fibre. A second impregnation serves to convey to the fabric the necessary mordants, usually the salts of a weak, volatile acid, e. g. acetic acid, after which the acid is expelled by steaming, and the colour-lake is thus produced and fixed upon the fibre.

By having separate baths for colouring matter and mordant, it becomes possible to use on the one hand any mixture of colouring matters desired, and on the other any combination of mordants.

c) A simpler method of carrying out the foregoing process, but which is only applicable in special cases and for pale shades, consists in adding to the colour solution an alkaline solution of a metallic mordant, which will not cause precipitation, e. g. aluminate of soda, ammoniacal chromic hydrate, etc. If fixed alkalis are used, the steaming must be done with steam which is highly charged with acetic acid, but in the case of ammoniacal chromic hydrate no such difficulties are experienced. This method is also capable of giving good results with the Resorcine Colours (Eosines, Rosazine, Roseline).

C.

General methods of Silk Dyeing.

Here, as in the case of wool and cotton, it is only intended to discuss the methods of dyeing silk, in so far as they depend upon the different nature of the colouring matters themselves. The scouring and preparation of the silk previous to dyeing, as well as the weighting process, and the influence of these upon the dyeing and the fastness of the colours obtained, all these matters will be dealt with in the second part of this work.

The salient properties of silk, namely its extraordinary lustre and the peculiar crisp handle known as 'scroop', should if possible remain equally prominent even after the dyeing process. Experience has shown, that, other conditions being suitable, these are only maintained in the highest degree, when the dyeing is carried out in a bath containing **'boiled-off liquor'**. This alkaline liquor which results from the scouring and boiling of the raw silk with soap, is always added to the dyebath, if at all possible. Only in certain branches of the trade, where no boiled-off liquor is at command, is the dyeing performed without its addition, but even in these cases attempts are made to imitate its action by the use of solutions of glue, dextrin, and starch.

This boiled-off liquor however plays an important part even in the dyeing operation itself, apart from its action on the lustre and handle of the silk. When raw silk is boiled in an alkaline soap-bath the silk-glue or silk-gum of the fibre is removed, and it is this substance which forms the chief active constituent of boiled-off liquor; and in the dyeing process the colouring matters are first taken up by the silk-glue in the bath and are only afterwards transferred to the fibre. — Hence the boiled-off liquor acts as the regulator of the dyeing process, it interposes during the progress of the union of the colouring matter with the fibre, and retards the dyeing, so that it has an important influence upon the evenness of the shades obtained. The amount of boiled-off liquor to be added to the bath, varies chiefly according to the nature of the colouring matter employed; as a rule it is about one fourth to one third of the total volume of the dye-liquor, according to the greater or less facility with which the colouring matter gives level shades; in the case of the alizarin-colours it is even usual to employ equal parts of boiled-off liquor and water to make up the dyebath.

The nature of the colouring matters employed determines the mode of applying them, and in accordance with this fact the methods of dyeing silk may be classified as follows:

1. Dyeing in neutral (or slightly alkaline, or slightly acid) boiled-off liquor, bath.
2. Dyeing in boiled-off liquor bath acidified with acetic acid.
3. Dyeing in boiled-off liquor bath acidified with sulphuric acid.
4. Dyeing in soap-bath with subsequent souring.
5. Dyeing after previous mordanting.
6. Dry-dyeing in benzene.

After the dyeing operation silk is always 'brightened' i. e. rinsed for a short time in water very slightly acidified with sulphuric, tartaric, or acetic acid, and then squeezed without washing. This after-treatment, or 'brightening', is necessary in order to give the silk the characteristic crisp handle known as 'scroop'. The choice of acid for this purpose depends upon the nature of the colouring matter employed in dyeing, hence it is that in the tables given in the earlier pages of this book, the brightening agent to be used is specially mentioned with each dyestuff.

I. Dyeing in neutral bath.

Easic-Colours are applied to silk in a neutral bath; this method depends upon the fact, that the silk-fibre, when steeped in solutions of the Basic Colours, has the property of combining with their colour-bases, to form insoluble compounds having the character of salts, in which the silk plays the part of an acid. — This process is accelerated by raising the temperature and by having the dyebath in a weak alkaline condition, on the other hand it is retarded if the bath is kept slightly acidified. — Strong acids, especially mineral acids, hinder the dyeing process. — In accordance with this general behaviour, it is usual to dye with the Basic Colours in the following manner: the dyebath is made up with $^1/_3$ boiled-off liquor and $^2/_3$ water, then acetic acid is added till the alkaline reaction has almost or entirely disappeared, and finally the carefully dissolved and filtered dyestuff is added. The silk is entered at 30—40° C. (85—105° F.), the temperature is then raised to near the boil, while continually handling the material, the dyeing being completed at 80—90° C. (175—195° F.). — Since an excess of acetic acid causes the Basic Colours to be taken up by the fibre slowly, while a deficiency has an accelerating influence, the dyer has it entirely in his power to regulate the dyeing process exactly as he desires. In the case of full deep shades the bath is kept as neutral as possible, in order to utilise the dyestuff to the fullest extent, since the large amount of colouring matter present in the bath, is sufficient to ensure that all parts of the silk will be dyed equally. On the other hand, with pale delicate shades it is customary to work with a slight excess of acetic acid in the bath, in order to prevent the fibre from taking up the colouring matter too rapidly, and to keep it longer in solution so that each part of the fibre will be equally dyed. — As a rule the Basic Colours are sparingly soluble, and their free colour-bases are for the most part insoluble and prone to precipitate in a tarry form; hence great care must be exercised during their solution. The colouring matters should be thoroughly well dissolved, and their solutions should always be filtered before being added to the dyebath; in this manner the occurence of dye-spots on the goods is prevented, defects which are all the more objectionable because once formed, they can scarcely ever be removed. For the purpose of dissolving the dyestuff, pure condensed water should always be used if possible, because calcareous water decomposes the basic colouring matters with separation of

the tarry colour-bases, thus giving rise to loss of dyestuff and the formation of dye-spots. — If no condensed water is available, acetic acid is first poured over the colouring matter, and then it is dissolved by mixing with boiling water. — Another excellent method of securing complete solution of the Basic Colours is to mix them well with an equal weight of pure glycerine and four times their weight of alcohol on the water-bath; when they have dissolved to a thick syrup, pure hot water is added and the whole is stirred till completely dissolved. — All Basic Colours can be mixed together in any proportion and employed for dyeing compound shades; they should however never be used in the same dyebath with colouring matters belonging to another group. With a great many colouring matters they form insoluble compounds by mutual precipitation, and this may readily lead to the formation of dye-spots, or it may cause the dye to rub-off, etc. — If therefore it is at any time necessary to use the Basic Colours in combination with colouring matters of other groups, this must only be done in separate baths freshly prepared, the operation being known as 'topping'. — For the purpose of brightening, acetic and tartaric acids are used, since, as a rule, the shades obtained with Basic Colours are considerably altered if sulphuric acid is employed.

II. Dyeing in acetic acid bath.

Resorcine Colours are dyed on silk in an acetic acid bath; this method is based upon the fact that the colour-acids of the dyestuffs of this group combine with the silk-fibre to form a kind of salt in which the silk-fibre itself acts the part of a base. Since the salts of the Resorcine Colours, (the remarkable purity and brilliancy of whose dyes are characteristic of the whole group), are not very stable and are readily decomposed, particularly by the action of mineral acids, with the liberation of the pale colour-acids, it is absolutely necessary that the dyeing should be effected in a bath **acidified** with acetic acid. This acid is sufficiently strong to liberate the free colour-acids, so that they may combine with the silk-fibre, but it is not so stroug as to prevent this combination from taking place. — The method of dyeing with the Resorcine Colours is as follows: the dyebath is made up with $^1/_3$ boiled-off liquor and $^2/_3$ water, and as much acetic acid as will make the bath perceptibly acid to the taste, or to blue litmus paper; the colouring matter previously dissolved in warm water is then added, and the goods are entered at 30—40° C. (85—105° F.). The temperature is raised to the boiling point with continual handling of the goods, and the dyeing is completed just below the boil. — The **Resorcine Colours**, which include the various marks of **Eosine, Erythrosine, Cyanosine, Phloxine and Rose Bengale**, give colours ranging from pink to red and varying from the most pronounced yellow shade to a very blue shade, all of which are remarkable for their extreme purity of tone and their characteristic fluorescence.

III. Dyeing in sulphuric acid bath.

All **Acid Colours** and **Azo Colours** are dyed on silk in a boiled-off liquor bath acidified with sulphuric acid; in this way the colour-acids are liberated by the excess of sulphuric acid employed, and they combine with the silk-fibre to form insoluble compounds in which the fibre acts the part of a base. By the addition of boiled-off liquor this union of colour-acid with the fibre is retarded and thus the necessary evenness of dye is secured,

since in the first instance the colour-acid combines with the silk-glue of the boiled-off liquor and only afterwards enters into combination with the silk-fibre itself. — If the proportion of boiled-off liquor in the bath is increased, the colouring matter tends to dye more level, because it is retained longer in the solution, its absorption by the fibre being retarded. — A diminution in the amount of sulphuric acid acts in the same direction, while an excess of acid accelerates the absorption of the colouring matter by the fibre and tends to produce unlevel dyeing. — The temperature of the dyebath is also of considerable influence: the higher the temperature the more rapidly does the union between colour-acid and silk-fibre take place, whereas the lower the temperature the more slowly does the dyeing proceed; hence, by regulating the temperature at which the goods are entered, and also the rate at which it is raised to the boiling point, the dyer can control the progress of the dyeing operation at will. — Apart however from the considerations which have just been pointed out, the evennes of the dye depends primarily upon the nature of the colouring matter employed; the greater the affinity existing between fibre and colouring matter, the more quickly is the latter absorbed by the former, and the degree of this affinity must necessarily influence the regularity or otherwise of the dye ultimately obtained.

The union of the colouring matter with the silk-fibre may take place even at the ordinary temperature, but not so rapidly nor so completely as at higher temperatures; hence colour-matching may be done in the cold and further necessary additions of dyestuff may be made, so long as the dyestuff is being taken up by the fibre slowly and regularly. As soon as the desired shade has been matched in this manner, the dyebath is raised to near the boil, and the dyeing process is completed by working the material just below the boiling point.

The dyes obtained with the Acid Colours, are, if possible, always brightened with sulphuric acid, for the sake of economy; with such colouring matters however as are sensitive to mineral acids, acetic acid is used instead. Compound shades which are dyed with a mixture of colouring matters, some of which are sensitive to mineral acid while others are not, are of course always brightened with the weaker acetic acid.

IV. Dyeing in soap-bath with subsequent souring.

Alkali Blues are dyed in soap-bath with subsequent souring; the affinity existing between the fibre and the colouring matters of this group is so great, and the union between the two takes place with such energy and rapidity both in acid and in neutral bath, that if the ordinary methods of dyeing are pursued the shades obtained are quite uneven. In a soap-bath, which is usually made up with so-called Marseilles soap (i. e. an olive-oil soap), the Alkali Colours dye much more evenly, because much more slowly, and in this way a level shade may be obtained. — In this bath the silk acquires a pale blue colour, and only by passing the dyed material through dilute sulphuric or hydrochloric acid, or through the solution of a very acid salt, is the deep blue colour of the free colour-acids developed. — The operation of dyeing silk with the Alkali Colours is conducted as follows: the dyebath is charged with 10—15% of Marseilles soap for light shades, or 20—30% for dark shades, as well as with the necessary amount of colouring matter. The goods are entered hot and dyed at the boil, with constant handling. The dyebath is not exhausted and must consequently be preserved for further use. After dyeing, the silk is thoroughly well washed and then soured in a hot acid bath. — The washing is of great importance, for it is necessary to remove from the silk-fibre every particle of loose

colouring matter, otherwise the dyed colour will inevitably rub-off. For washing, the water should be as free from lime as possible; calcareous water gives rise to the formation of lime-soap, which encloses mechanically any colouring matter which is not fixed, and thus also causes the dye to rub-off. As a rule the souring is done with sulphuric acid, but in cases where a high degree of fastness is required, a mixture of a metallic salt and an acid, usually stannous chloride and hydrochloric acid, is employed.

V. Dyeing after previous mordanting.

This method is adopted with the so-called **Mordant Colours**, which by themselves do not yield any useful dyes, but only when they are caused to combine with certain metallic oxides. When silk is steeped in the solutions of certain metallic salts, it has the property of attracting and fixing their metallic oxides, either in the form of hydrates or as very basic salts, and so intimate and thorough is the combination, that the most energetic washing fails to effect disunion. If now the silk so prepared, or 'mordanted' as it is termed, is entered into a fresh bath containing the Mordant Colours, and especially if the bath is heated, the colour-acids combine with the metallic oxides already fixed upon the silk, to form very insoluble and therefore very stable, or fast, coloured lakes. -- The chief mordants employed in this manner in conjunction with the Mordant Colours are as follows:

1. 'Nitrate mordant'. This is the solution of a slightly basic aluminium nitrate-acetate.
2. 'Nitrate of iron'; a solution of basic ferric sulphate.
3. 'Chrome mordant G A III'; a solution of chromium chromate.
4. 'Chloride of chrome S'; a solution of basic chromium chloride.

The silk is well wetted-out in these mordant solutions by continued handling for a short time, and then allowed to steep for several hours, or preferably over-night; it is then wrung-out or squeezed, and finally thoroughly well washed with repeated changes of water; this washing removes excess of acid, which tends to hinder the dyeing process, as well as any unfixed mordant, which would give a colour liable to rub-off. — The silk is now mordanted and ready for dyeing. —

The dyeing is carried out in a bath well charged with boiled-off liquor, (usually half boiled-off liquor and half water), in order to cause the fibre to take up the colouring matter slowly, and thus to ensure the necessary regularity, handle, and lustre of the dye ultimately obtained. — Addition of acetic acid accelerates the absorption of colouring matter enormously; to prevent therefore any irregularity of shade, acetic acid is only added to the dyebath when dyeing full dark shades, since in this case the large quantity of colouring matter present itself ensures equal dyeing of all parts of the silk fibre, but for medium and pale shades no acetic acid at all is added to the bath. The silk is entered cold, and worked in the cold for half an hour, then the temperature of the bath is gradually raised in the course of an hour to near the boiling print. At this temperature the material is worked for another hour, and the union between colouring matter and mordanted fibre is thus completely effected. The dyed silk is washed, then well soaped in a strong soap-bath, again well washed, and finally brightened with tartaric acid.

VI. Dry dyeing in Benzene.

This method is adopted with a few **Basic Colours** and **Azo Colours soluble in benzene**, also with the so-called **Fat Colours** i. e. specially prepared basic-colours consisting of colour-bases in combination with fatty acids or the acids of resin (resinates). In this case the dyebath consists of benzene, to which alcoholic solutions of the requisite colouring matters are added. — The method is employed in special cases in garment dyeing, but only for pale shades, since it is not at all suitable for dark shades. The chief advantage of the process is that the cleaning and the dyeing of the garments are effected simultaneously while the handle and finish of the materials remain unimpaired.

D.

General Methods of dyeing Jute

(Cocoanut-fibre, Straw, Wood).

The Jute fibre, so far as its behaviour towards colouring matters is concerned, comes between the wool and cotton fibres. The presence of large amounts of tannin-like compounds, with which the fibre is incrusted, enables it to attract and fix a large number of colouring matters directly i. e. without the aid of any mordant. Generally speaking there are two methods in use for dyeing Jute, namely:

I. Dyeing in neutral bath.

II. Dyeing in weak acid bath.

I. Dyeing in Neutral Bath.

The dyeing in neutral bath is adopted with the Basic Colours. This method is based upon the fact that the Jute fibre is permeated and incrusted with substances of a tannin-like character, with which the colour-bases of the Basic Colours form insoluble compounds, whenever the fibre is worked at a moderate temperature in dilute solutions of these colouring matters. The affinity of the fibre for the colouring matter is rather pronounced, hence it is necessary, especially in the case of pale shades, to enter the goods at a low temperature and to raise it gradually to 70—80° C. (160—175° F.), at which temperature experience has shown the colouring matters to be fixed most completely. Additions of acetic acid or alum retard the dyeing process by reason of their solvent action on the colour-bases, hence they must not be used for full deep colours, and never in very large quantity.

The sparing solubility of most of the Basic Colours and the insolubility of their colour-bases, which latter are readily precipitated in a tarry form by any carbonate of lime or magnesia present in the water used for dissolving the colours or for the dyebath, render

it imperative always to thoroughly dissolve the colouring matters previously in non-calcareous hot water, and to add the solution to the dyebath, if at all necessary, through a flannel or grass-cloth filter. — If non-calcareous water, for example condensed water, is not available, it is well to pour some acetic acid over the colouring matter and then to dissolve it by adding boiling water. — If the water of the dyebath is very calcareous it should be corrected by adding acetic acid, in order to prevent the production of dye-spots and loss of colouring matter; for water having 6^0 hardness about $^3/_4$ gill of acetic acid 11^0 Tw., and for 12^0 hardness about $1^1/_2$ gills are is required for 220 gallons.

All the Basic Colours may be satisfactorily fixed on Jute by this method so as to be fast to washing, but the following are specially applicable: **Auramine, Chrysoïdine, Vesuvine, Safranine, Methylene Violet, Magenta, Cerise and other low qualities of magenta, Methyl Violet, Navy Blue, Methylene Blue, Fastblue for cotton, Methylene Grey, Coal Black, Methylene Green, Brilliant Green, Malachite Green, and the Rosazeïnes.** — They are used either as self-colours, or in combination with each other, for the production of fancy or standard shades.

II. Dyeing in Weak Acid Bath.

The Jute fibre is capable of combining with a large number of **Acid, Azo,** and **Resorcine Colours,** when they are applied in a boiling acid bath. Since, however, the fibre is very sensitiv eto acids, and is readily attacked and tendered by mineral acids, even when these are very dilute, only very weak acids, e. g. acetic acid, or acid salts, e. g. alum or aluminium sulphate, can be employed as additions to the dyebath. When dyeing Jute with **Acid Colours** the acetic acid or alum appear to act in the same manner as the sulphuric acid employed in dyeing wool. Since the affinity of the fibre for the colour-acids is not very pronounced, the dye-baths are not exhausted, and the colours obtained are very level, since on boiling, a perfectly equal distribution of the dyestuff takes place. The dyeing is conducted at the boil with the addition of about 2 % acetic acid and 2—5 % alum, and with most colouring matters it is possible to shade at the boil, by adding the necessary dyestuff in small portions at a time, as required. — With the **Resorcine Colours,** e. g. the various marks of **Eosine, Erythrosine, Phloxine** and **Rose Bengale,** the amount of acid must be as restricted as possible, since an excess of acid gives a less Brilliant colour. — Of the various **Acid Colours** the following are specially useful: **Acid Green** (various marks), **Patent Blue A, Soluble Blue, Bleu de Lyon, Blue for Cotton, Fastblue, Blackblue, Blackblack, Acid Violet 7BN, 5BF, N,** and the various **Fast Acid colours.** Other readily soluble Acid Colours are less useful, because they are only incompletely taken up by the fibre, a good deal of colouring matter remaining behind in the dyebath. The above mentioned Acid Colours should be dissolved in boiling water, (as free from lime as possible, preferably condensed water), and the solution is then added to the dyebath; the colouring matters should never on any account be dissolved in the acid liquor of the dyebath itself, because this practice readily causes the precipitation of sparingly soluble or altogether insoluble colour-acids, which leads to loss of dyestuff and the production of dye-spots. — A large number of **Nitro Colours and Azo Colours** are suitable for dyeing Jute, more particularly the following: **Naphthol Yellow S, Azo Yellow, Victoria Yellow, Orange No. 4, Orange No. 2, Brilliant Orange,** various **Scarlets Paper, Scarlet, the Brilliant Croceïns, Fast Red, Claret Red, Fast Claret Red, Fast Brown,** etc. — The **Azo Colours** on Jute are not so fast to washing as the **Basic Colours,** but they are much faster to light. The **Azo Colours** may be employed with each other and with the Acid

Colours in any desired combination, for the production of compound and fancy shades. — On the other hand **Basic Colours** must never be used in the same bath either with Azo, Acid, or Resorcine Colours, since mutual precipitation ensues, resulting in loss of dyestuff and possible production of dye-spots. — If it is necessary at any time to apply Basic Colours in conjunction with Acid, Azo, or Resorcine Colours, the best plan is to top with the latter in a separate acid bath.

Cocoanut-fibre, Straw, and Wood are dyed in a similar manner to Jute, since their behaviour towards colouring matters is very like that of Jute. — In many cases, and for special purposes, Wood and Straw are also frequently dyed by painting over with coloured spirit-varnishes.

THE METHODS

OF

APPLYING COLOURING MATTERS BY MEANS OF PRINTING.

The methods of applying colouring matters by means of printing.

I. Methods of fixing the Basic Colours.

The so-called Basic Colours are the simple or double salts of colour-bases, they possess the common property of forming with tannic acid sparingly soluble or even insoluble compounds, having the character of salts and called **Tannin-lakes.** Moreover they show a great **affinity for the animal fibres wool and silk,** partly also for the jute fibre, which appears to contain certain substances possessing properties similar to those of tannic acid.

In most of the Basic Colours the acid combined with the colour-base is hydrochloric acid, less frequently it is acetic, sulphuric, oxalic acid, &c. Many are double-salts and contain zinc chloride.

Since however those printing-colours which contain zinc chloride are apt to attack the cotton fibre during the steaming operation, it is usual for the purpose of calico-printing, to employ the simple salts and not the zinc double-salts. Certain colouring matters of the Induline series differ from most other Basic Colours by being only sparingly soluble in water, acetic acid, or alcohol; for these, special solvents are required, the most important of which are acetine and ethyl-tartaric acid.

In addition to tannic acid there are other substances capable of precipitating the Basic Colours, e. g. chromates, potassium ferricyanide, arsenite of alumina, ferro-cyanides, resin-soap, &c., but up to the present these have not found any extensive practical application. For the complete precipitation of the Basic Colours and for the production of a lake of the highest degree of stability or fastness, each colour requires the addition of a certain definite amount of tannic acid, for a deficiency, as well as an excess, of tannic acid is injurious, the latter by reason of the formation of acid tannates which are more soluble.

The Basic Colours, or Tannin Colours, as they may well be named, are applied to **cotton** as so-called **steam-tannin-colours,** except in the production of certain **discharge-styles,** in which case they are applied by a dyeing process.

For this purpose the colouring matter is disolved in a suitable medium (e. g. water, acetic acid, alcohol, tartaric acid; or, if for printing, inethyl-tartaric acid, alcohol, acetine, &c.), the solution is thickened, and to the thickened colour is added an acetic acid solution of tannic acid. In order to prevent any premature lake-formation in the printing-colour,

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as well as to retard its occurrence during the steaming operation, thus to ensure a more thorough colouring of the fibre, it is usual to add further, to the printing-colour itself, a little tartaric acid, ethyl-tartaric acid, acetine, glycerine, &c.

The operation of **steaming** which follows that of printing is for the purpose of rendering the tannin compound of the colouring matter insoluble, partly by the action of the steam, partly by evaporating the solvents e. g. acetic acid, or alcohol.

To effect complete fixation of the tannin-lake, the printed material, after steaming, is passed into a **tartar-emetic-bath.** In this operation the lake takes up a certain quantity of oxide of antimony and is thereby rendered faster to soap. In place of tartar-emetic other antimony salts, e. g. oxalates, double fluorides, &c., as well as zinc salts may be employed.

The additions of glycerine and acetine to the printing-colour have the further advantage of protecting the fibre during the steaming process, from the tendering action of the hydrochloric acid which is liberated, or of the tartaric acid present in the colour. It is for the same reason that ethyl-tartaric acid is so frequently used instead of tartaric acid itself, since its slow decomposition during steaming into alcohol and tartaric acid, affords considerable protection from the occurrence of any corrosive action.

An attempt has been made to add antimony compounds to the printing-colour, with the object of omitting the subsequent passage through the tartar-emetic bath. For this purpose, certain basic antimony salts e. g. basic antimony oxalate, seem to be suitable, but the method has not been much used, since it is difficult to prevent the premature formation of colour-lake.

In **wool and silk printing** the Basic Colours are almost always applied substantively, i. e. without the addition of tannic acid, but they are not so extensively employed for wool as the Acid Colours, since the latter furnish prints which on the whole are faster to light.

Nevertheless the Basic Colours possess certain advantages, for example, that the preliminary treatment of the wool with chlorine can be more readily dispensed with than in the case of the Acid Colours, and that they give level colours which are as a rule satisfactorily fast to washing. The colouring matters are dissolved in water, acetic acid or alcohol, or in a mixture of these solvents, and after thickening with gum, dextrine or British-gum, a small addition is made of acetic acid or some fixed organic acid.

Fixation of the colour is effected by steaming for 1—2 hours with steam which is made as moist as possible. For dark brown and black blotch-colours the various marks of Magenta are employed, also such Magenta by-products as Cerise, Maroon, Garnet &c., either alone or in combination with some green colouring matter (e. g. Brilliant Green) &c., and with the extracts of such natural dyestuffs as logwood, sapanwoo, dor fustic; considerable eus is also made of Phosphine either alone or as an addition to discharge-colours.

II. Methods of fixing the Eosine Colours.

The Eosine Colours, most of which are remarkable for giving very brilliant shades have little or no affinity for the vegetable fibres; they behave in this respect therefore in a similar manner to the Acid Colours, and like them are largely employed in wool and silk printing.

It is important to note however that, with metallic mordants, especially chrome mordants, they possess the property of forming **lakes**, and these are fairlyfast to washing and soaping.

They are therefore used to some extent in calico-printing.—The preparation of the woollen materials before printing with Eosine Colours, as well as the printing, steaming, and finishing operations, are the same as when printing with Acid Colours. Here too it is usual to add a small quantity of ammonia or carbonate of soda to the printing-colour.

Since the Eosine Colours withstand the action of reducing agents extremely well, they are particularly useful for coloured discharges and resists.

III. Methods of fixing the Acid and Azo Colours.

The Acid Colours are salts of the sulphonic acids of various colouring matters, they possess no direct affinity for cotton, neither are they satisfactorily fixed on this fibre by means of tannic acid or by metallic mordants. The animal fibres wool and silk, on the other hand, show a very marked attraction for these colouring matters, hence they are almost exclusively employed for these fibres. The shades they yield on wool and silk are for the most part very bright, and in many cases they are also satisfactorily fast to light and soap. Certain Acid Colours find occasionally a limited employment even on cotton fabrics; for this purpose they are simply thickened and printed, without any addition at all being made to the mixture, or sometimes with the addition of aluminium or chromium salts, but the colours obtained are as a rule extremely loose on washing and fugitive to light.

The **printing with Acid Colours on wool** (in its different stages of manufacture as: slubbing, yarn, and cloth) is a very important feature in connection with this fibre, and hence will be referred to first.

The material to be printed is submitted to a preliminary treatment, which consists in scouring it with slightly alkaline solutions in order to make it perfectly clean, after which it is in most cases bleached and chlorinated.

The **scouring** or washing in tepid solutions of soap or ammonium carbonate effects a complete removal of the natural grease or yolk and also dirt adhering to the fibre, and thus makes it better able to take up the colouring matter subsequently presented to it.

The next operation, **bleaching**, was formerly always carried out with sulphurous acid, which was applied either in the form of gas in the so-called sulphur-stoves, or by passing the fabrics through baths containing sulphites. In this process the bleaching is due to the formation of colourless sulphites of the natural colouring matter of the wool; the operation is succeeded by a treatment with weak acids, after which there usually follows the so-called chlorinating operation. In recent years hydrogen peroxide and sodium peroxide have been successfully employed in the bleaching of wool, their use being often combined with the sulphur-bleach.

Of all the preliminary operations to which the wool is submitted before printing, none produces such a marked effect as that of chlorinating, for it is well known that by the action of hypochlorous acid upon wool its affinity for colouring matters is very much increased.

This effect is strikingly shown in the case of the Acid Colours, and when printing with the Mordant Colours, more particularly the Alizarin Colours, it is absolutely necessary, if dark colours are required, to print on chlorinated wool. The operation of chlorinating is carried out by passing the wool through acid baths containing hypochlorous acid, care being taken that the fibre is not attacked and that the white does not assume a yellowish tint

Any deterioration of the wool during the chlorinating operation is specially to be avoided in the case of slubbing intended for melange-printing, otherwise the spinning and milling properties of the wool may suffer very considerably. The yellowing of the wool is best prevented by employing a considerably larger proportion of acid than is required merely to decompose the bleaching-powder employed, moreover experience has shown that the use of sulphuric acid and hypochlorite of soda (made from bleaching-powder and sodium carbonate) gives a better white, than when bleaching-powder and hydrochloric acid are employed. The chlorinating of wool may be regarded as a kind of mordanting of the fibre, and its action is usually intensified by 'stannating' i. e. preparing with stannate of soda. This operation may be performed either before or after that of chlorinating, and consists in padding the woollen fabric with a solution of stannate of soda, and then passing it through dilute acids or through an acid chlorinating bath. The following hints relative to the printing with Acid Colours on wool prepared as above described, will be found useful.

The **printing-colours** are usually acid or slightly alkaline but seldom neutral, thickened solutions of colouring matters, to which certain additions are made for the purpose of influencing the shade, the evenness, or the fastness of the colour. Acids are added in the case of the sulphonic acid Rosauiline Colours and with most of the Azo Colours, including for example: acetic acid, which acts partly as a solvent, also such fixed organic acids as tartaric and oxalic acids, as well as sulphuric acid or an acid sulphate. Of the alkaline additions employed, the following may be mentioned: ammonia, soda (in small amounts), borax, and phosphate of soda: these too help to facilitate solution of the colouring matter. For pale shades more particularly, or with colouring matters which only give level shades with difficulty, the addition of a little ammonia to the printing-colours may be recommended. Additions of certain metallic salts alter the normal shades otherwise obtained, or they exercise a beneficial influence upon the fastness of the colour.

The **Chromotrope dyes** are well known to be radically changed in shade by the action of metallic salts, and equally interesting is the improvement in fastness to milling of certain Acid Colours, e. g. Patent Blue, &c., effected by the use of Fluoride of Chromium. The **Printing** of the colours on wool is done exactly in the same way as on cotton, but it is well to observe that the engraving of the printing-rollers should be deep, that the pressure during printing should be soft and elastic, and that the printed fabrics should be gently dried. The **Steaming** is usually done without pressure and frequently with steam made specially moist for the purpose, high-pressure steam is seldom used. Since, to obtain full colours, the steam should be as moist as possible, care should be taken not to dry the pieces too hard after printing, indeed they may even be submitted to a special damping operation. This is done, either by allowing the printed and dried pieces to be run between two damp greys, or by hanging them in a cool moist chamber.

After steaming, the pieces are washed, then occasionally soaped and dried. The **washing** must be carefully done if good whites have to be obtained; cold hard water gives better results than soft water, especially if the latter is warm, as is frequently the case in summer time.

The Acid Colours are printed on silk in the same manner as on wool, their application to this fibre presents indeed fewer difficulties, since their affinity for silk is sufficiently great to enable one to dispense with the chlorinating operation. The preparation of the printing-colours, which are mostly acid, is the same as for wool; steaming with dry steam suffices to fix the colours completely.

Here too the **washing** demands the greatest care and attention, since, owing to its great affinity for colouring matter, the silk readily attracts any loose colour present in the wash-water. Soaping after washing is seldom required, but very frequently the material

is submitted to a brightening operation in weak acid baths, in order to give the silk a better handle and more lustre.

The Acid Colours are largely used on woollen and silk fabrics in **discharge** and **resist styles**. For the former, the dyed pieces are printed with discharges containing stannous chloride or zinc powder, and then steamed, the effect of which is to destroy the colour in the printed parts and to restore the original colour of the fibre. By adding to the discharge printing mixture such colouring matters as resist the action of the above reducing agents, and which at the same time are capable of being fixed on the fibre by steaming, coloured discharges are obtained. A special resist method for the production of white and coloured patterns on silk is the so-called resin-resist method, which will be referred to more fully in the second part of this work.

IV. The Mordant Colours.

Among all the colouring matters employed in the trade of printing the fastest prints are those obtained by employing the so-called **Mordant Colours**, hence these have been extensively used from the earliest times. The great **fastness** of the dyes or prints they yield, i. e. their power of resisting the action of light and washing, is due to the fact that these Mordant Colours have the property of combining with the oxides of aluminium, chromium, and iron, to form very stable compounds, namely the so-called **lakes.**

Without entering upon any detailed explanation of the theory of lake-formation, it may be here stated, that as a rule several constituent elements are required to produce a lake, among which some are organic (e. g. fatty-acid compounds), and it is interesting to note that it is particularly the lakes of a more complex character, which very frequently exhibit the greatest brilliancy and fastness.

It is well known, for example, that Turkey-red an Alizarin-red, so remarkable for its unequalled fastness, is considered to be a lake composed of fatty-acid in combination with alumina, lime, and alizarin, the brilliancy of which is still further increased by the introduction of tin. The metallic oxides which constitute the mordants determine, not only the fastness of the lakes, but also and indeed primarily, their colour. Alizarin affords an excellent illustration of this latter point. This colouring matter gives with aluminium mordant, according to its intensity or concentration, shades which vary from pink to red, with chromium mordant from pale violet to dark violet-brown, and with iron mordant from violet to black shades.

There are two methods of employing the Mordant Colours:

1. **The first method consists in applying the mordant to the fibre, and then dyeing the mordanted fibre.**

2. **In the second method, the colouring matter and mordant are applied simultaneously, i. e. they are fixed upon the fibre in one operation.**

The first method produces what are usually called **fast dyed goods,** the latter gives what are known in the printing trade as **steam styles.**

The inorganic mordants required for fixing the Mordant Colours include: **aluminium, iron, chromium,** tin, calcium, magnesium, cobalt, and nickel mordants. Of these the first three alone are of any great importance and are those generally employed, the last two are only used in very special cases, while the calcium and magnesium mordants can only be regarded as assistant-mordants, for example in the production of compound lakes (alizarin-red, &c.).

The nature of mordants and the methods of their manufacture will be treated of in a special chapter entitled 'The Mordants', hence it will suffice here if an explanation is given of their function. The inorganic mordants used both for dyed-colours and steam-colours must give up their oxides to the fibre easily, as completely as possible, and in such a form as to dye readily, further, without in any way causing injury to the fibre either by the deposition of the oxide or by the liberation of acids or alkalis.

Since the vegetable fibres are seriously tendered by mineral acids at high temperatures, an endeavour is made to diminish this influence as much as possible by employing basic salts as mordants, and by largely replacing the mineral acids by volatile acetic acid which is harmless.

It is well known that the dissociation of aluminium, iron, and chromium mordants depends not only on the temperature employed, the degree of dilution of the solution, and the nature of the fibre, but also and indeed in an important degree, on the basicity of the mordant, for the more basic the mordanting salt is, the more readily will it give up its oxide to the fibre.

Hence it is that most of the inorganic mordants employed by the calico-printer are **basic salts** of the above mentioned metals, the acids being one or other of the following: sulphuric, hydrochloric, nitric, hydrothiocyanic, sulphurous, acetic, tartaric, and occasionally oxalic acid, these being used either alone or in conjunction with each other.

In certain cases **alkaline mordants** are employed, e. g. aluminate of soda, or a solution of chromic hydrate in sodium hydrate, with or without addition of glycerine, &c. Since the Mordant Colours are for the most part employed in calico-printing, it may be well to give now a brief survey of the methods and processes employed in the production of **fast dyed goods** and of **steam-styles.**

A. Employment of Mordant Colours for Fast Dyed Styles.

In discussing this style the following operations require consideration.

1. **The printing of thickened mordants on bleached calico, or of resist and discharge colours on mordanted cloth.**

2. **The fixing of the mordants and the preparation of the goods for dyeing.**

3. **The dyeing operation.**

4. **The after-operations and finishing** of the dyed goods, with the object of increasing the beauty and fastness of the colour (e. g. oiling, soaping, steaming), or for the purpose of clearing the white by soaping, chloring, &c.

With respect to the **printing of the thickened mordants,** it is to be observed that the goods must be bleached with the utmost care and thoroughness, since if any impurity is left behind (fatty matter, lime, iron, &c.) or if the cellulose is altered chemically (oxycellulose), either the colour or the white ground is sure to suffer, and it should never be forgotten that the purity of both these elements in the finished print is of the greatest importance.

The mordants which are printed on the cloth not only contain mordant and thickening, but very often certain additions, with the object either of modifying the shade (tin compounds, &c.), or, as in the case of iron mordants, of regulating the oxidation and fixation of the mordant (arsenious acid, copper salts, phosphorous acid, &c.).

Further, since the mordant solutions are either colourless or at most only slightly coloured, it is necessary to add to the printing mixture so-called 'sightening', in order to render

the impression visible to the printer. This sightening, which is removed during the fixing operations, consists of such colouring matters as Magenta, Methyl Violet, Sapan-extract Fustic-extract, &c.

The choice of thickening material is a matter of considerable importance; as a rule, flour and starch thickenings are preferred to those of dextrine and gum.

After the mordants have been printed they require to be **fixed,** an operation which takes place in two stages.

The first stage which is improperly termed the, **ageing,** process is based on the fact that under the influence of heat, moisture, and air (iron mordants), the mordants give up their oxides to the fibre in an insoluble form, while the liberated acetic acid evaporates. The operation consists in hanging the printed goods in a moist, warm, airy chamber, called an ageing-room, or they are submitted to a short steaming process in an 'ageing-machine' or a continuous steaming apparatus, which in frequently followed by a passage through ammonia vapour.

The second, the so-called **dunging or fixing operation,** consists in passing the goods through fixing and cleansing baths, with the object of completing the fixation of the mordant and removing the thickening. For most mordants, with the exception of those which are alkaline (aluminate of soda, chromite of soda), it is usual to employ warm or hot baths containing the necessary fixing agents, e. g. sodium carbonate, phosphate of soda, silicate of soda, arsenate of soda, with or without the addition of ammonia or chalk. Not unfrequently cowdung is added to the bath (alizarin colours) and also chalk. When phosphate or arsenate of soda is employed a certain portion of the phosphoric and arsenic acid is taken up by the mordant, and they exercise some influence on the shade and fastness of the colour ultimately obtained.

The well washed goods are usually **dyed** in the, chain, only occasionally in the 'open-width' form. The colouring matters are added to the dye-bath either in a state of solutino or, as in the case of sparingly soluble colouring matters, in a state of fine subdivision, as pastes. When dyeing with Alizarin Red it has been found advantageous to add it to the dye-bath in alkaline solution (with borax), and then by adding the calculated amount of hydrochloric or acetic acid, to precipitate it again in a very finely divided state. By this means its dyeing power is increased in a most remarkable manner. Along with the colouring matter certain additions to the dye-bath are made, their object being as follows:

1. To take part in the lake-formation.
2. To prevent the white unmordanted parts of the fabric from becoming stained.

As assistants which are necessary to aid in the formation of the colour-lake may be mentioned more particularly lime-salts (e. g. in dyed alizarin reds), also fatty-acid compounds (Turkey-red oils) tannic acid, sumach &c. For the purpose of preventing the staining of the white ground the following assistants are employed: tannin matters, e. g. sumach, tannic acid, also glue, bullock's blood, &c.

The regulation of the temperature of the dye-baths varies with the different dye-stuffs and according to the composition of the dye-baths; as a general rule however, and in order to obtain full, level colours, it is customary to dye first at a low temperature and then to raise it slowly until the dye-bath in exhausted. Occasionally the pieces are dyed in the open-width. In this case the dye-bath is made more concentrated, and is heated to a higher temperature, in order to complete the dyeing operation in as short a time as possible.

The **after-operations** to which the dyed goods are submitted have a double object in view:

1. **Clearing the white ground** by washing well with water, warm bran-baths, soap-baths and chloring.

2. **Increasing the fastness and beauty of the colour-lake,** e. g. by oiling, steaming, soaping, and clearing, as in the case of alizarin-red.

By treating dyed alizarin-red with Turkey-red oil and then steaming, the brownish-red lake as produced in the dye-bath is changed into one of a brilliant red colour. The operations of soaping and particularly that of clearing, which consists in boiling with soap solutions under pressure, with or without the addition of tin compounds, effect a considerable improvement in the fastness and purity of the colour by introducing into the lake a certain amount of fatty-acid and tin compounds.

The **employment of alkaline mordants** necessitates a somewhat different method of fixation from that already described.

The most important and at the same time the most largely used alkaline mordant namely an alkaline solution of chromic hydrate, is fixed in a perfectly satisfactory manner by the dissociating action of the fibre itself, for it suffices to impregnate the cotton with the solution, and after allowing it to remain for some time in the moistened condition, to wash it well with water, when it is at once ready for dyeing. When aluminate of soda is used, certain fixing baths containing ammonium chloride or zinc sulphate are required in order to fix the alumina. In the latter case zinc hydrate is also precipitated, so that a double-mordant is present on the fibre.

In the so-called **Fast dyed Discharge or Resist Styles** the goods are printed with, or padded in, a solution of the mordant, and then printed with acid discharge-colours, either at once or only after fixing the mordant. In the Resist Style the acid colours are printed **before** the mordanting. In the printed parts the mordant is dissolved, and in the case of fixed organic acids being used (e. g. tartaric, citric, and oxalic acid), double-salts are formed which are not precipitated by the fixing baths. The further treatment of the mordanted, discharge-printed, and fixed goods, is carried out in the manner already described.

B. Employment of Mordant Colours in Steam Styles.

The mordant colouring matters are largely used for steam-colours, especially in cotton and silk printing.

This method of employment consists essentially in **dyeing with a highly concentrated solution.** In addition to the thickening these steam-colours contain in a suitable form, first, all the necessary ingredients for the production of the lake, with the exception of fatty-acid compounds which are almost always applied by a preparatory treatment of the material with solutions of Turkey-red oil or soaps; secondly certain solvents, chiefly in the form of free organic acids, the most important of which is **acetic acid,** whose function is to prevent the premature combination of the colouring matter with the mordant at the ordinary temperature. Other solvents used are glycerine and tartaric acid, the latter being only employed in small quantity. The steam-printing-colours contain the dyestuff either in solution, or more usually in paste form; in the latter case the steaming operation effects a gradual solution of the finely divided precipitate of which the paste is composed; if the colouring matter is not thoroughly well mixed with the thickening, &c., an irregular print and paler colours result. The formation of the colour-lake is brought about by the joint action of the high temperature and moisture of the steam, which cause the combination of colouring matter with mordant; this union takes place by degrees during the gradual evaporation of the volatile solvent of the lake,

namely the acetic acid, while simultaneously fresh portions of colouring matter are continually being brought into a temporary state of solution.

As regards the mode of procedure, the **steaming of the printed goods** varies according to the nature of the colours. With respect to the kind of steam employed, it may be, for example:

1. Moist steam,
2. Dry steam,
3. High-pressure steam.

In accordance with the quality of steam required, and the necessary duration of the process, which may vary from a few minutes to two hours, the form of steaming apparatus to be employed must also vary; it may be closed or open, and may be worked intermittently or continuously. Without entering into the details of the construction of the ordinary steaming chambers, it may be explained, that in the intermittent process the goods are folded and wrapped in sheets and then hung in the steam-chest, whereas in the continuous process the chamber is provided with rollers and the pieces run through continuously in the open-width.

Not unfrequently a **preliminary steaming** of the goods precedes the steaming proper; its object is to effect a partial fixation of the colours, and to expel the major portion of the acetic acid, which otherwise would seriously corrode the iron plates of the chamber, as well as prevent in many cases the full development of contiguous colours. This preliminary steaming is done by the continuous process in the open-width.

Free mineral acids or fixed organic acids, even when employed in small amount, tender the fibre at the high temperature employed, hence it is that certain assistants are added to the printing-colour in order to prevent this deleterious action. For this purpose it is usual to employ the acetates of the alkalis and alkaline earths e. g. sodium or potassium acetate, &c.; sometimes glycerine is used, since it tends to reduce the destructive action alluded to, partly also because it has the property of fixing hydrochloric acid direct, and partly because of its hygroscopic qualities.

The **after-operations** to which the steamed goods are submitted consist in clearing the prints and adding brilliancy to the colour-lakes by washing, soaping, and chloring. In the case of fast-dyed goods the dunging operation aims primarily at fixing the mordant, but here, with steamed goods, the operation which follows that of steaming is solely for the purpose of removing the thickening and other ingredients of the printing-colour which do not form fixed constituents of the lake. The operation consists in washing the goods well in cold water or in baths containing chalk, bran, malt, or soap, the goods themselves being either in the open-width or in the chain form.

In order to obtain a perfectly pure **white ground** the goods are usually chlored, that is, they are first run through a weak solution of bleaching powder or hypochlorite of soda, and then either

1. passed through a steam-box **(steam-chloring)**, or
2. dried on steam heated cylinders **(dry-chloring).** Occasionally these methods may be replaced by a passage through a very dilute and cold solution of chlorine (vat-chloring).

Further details connected with the fixing of individual Mordant Colours in dyed and steam styles, will be given in the second part of this work, together with receipts and patterns; suffice it to say for the present that the Mordant Colours and especially the Alizarin Colours enable the production of a great variety of colour effects, which, although surpassed in brilliancy of shade by many Basic and Acid Colours, have the advantage of superior fastness, and it is indeed largely owing to these valuable properties of the Mordant Colours that the calico-printing industry occupies its present commanding position.

V. The direct production of colours on the fibre.

The production of colours upon the fibre itself by printing, comprises all those processes in which the chemical reactions leading to the production of a dyestuff take place on the fibre, hence it is evident that for this method only those synthetical processes are suited, which do not exercise any injurious action on the fibre.

For this reason, in calico-printing, one must avoid temperatures which are much above the boiling point of water, and the use of concentrated acids, or even dilute acids if a high temperature be employed.

At the present time therefore, there are but few typical reactions which have been applied in practice for the direct production of colours on the fibre, and of these only the two most important types will be referred to, namely:

A. Aniline Black.

B. Azo Colours produced on the fibre direct.

A. The production of Aniline Black.

Aniline Black is formed under certain conditions as an oxidation product of aniline and its homologues, and is remarkable for its excessive fastness towards washing and light.

It is very largely employed for **cotton**, both in the printing of yarn and cloth, less frequently for **wool, silk,** and union fabrics.

In the case of wool a preparatory treatment with hypochlorous acid is required.

In cotton printing one may distinguish between **Aged Aniline Black** and **Steam Aniline Black,** according as the development of the black is effected by hanging in a moist, warm ageing-chamber or by steaming. The mixture applied to the fabric by printing or padding may be thickened or unthickened, and it contains in addition to the **aniline salt** (e. g. hydrochloride, nitrate, hydro-ferro- or hydro-ferri-cyanide) certain **oxidising agents** (chlorates), and also so-called **oxygen-carriers** (copper, vanadium, and cerium compounds), which initiate, regulate, and continue the reaction. Since the formation of Aniline Black is due to an oxidation process which is not only energetic but which also as a rule proceeds with considerable rapidity, there is always the danger of the formation of oxy-cellulose accompanied by tendering of the fibre, hence the process demands the greatest care, and attention to the regulation of the temperature, the degree of moisture, and the duration of the steaming operation. Aniline Black is employed in calico-printing not only for printing, but also as a padding-colour, the latter being applied in conjunction with white and coloured **resists.** The resist printing-colours contain sulphites, alkali carbonates, caustic alkalis, acetates, and thiocyanates, i. e. substances capable of neutralising acid, the presence of which is so necessary to the formation of the black. Further details regarding this very interesting Resist Style will be given in the second part of this work.

B. Production of Azo Colours on the fibre.

The formation of Azo Colours, which depends upon the reaction of **Diazo** or **Tetrazo compounds** with phenols or amines, excels all other synthetical processes as regards its suitability for being effected on the fibre itself, since the conditions under which

the substances named react upon each other, are exactly suited to the nature of the **cotton fibre,** which is the only fibre to be considered.

Up to the present all the Azo Colours produced direct upon the fibre as insoluble substances are Oxy-azo compounds, which are obtained by the union of diazo or tetrazo compounds with phenolic bodies, e. g. naphthols, these obtained with β-naphthol being by far the most important and the most largely employed.

These colours, so remarkable for their brilliancy, their fastness to washing and to light, and so simple in the method of their production, are obtained by the union of diazo or tetrazo compounds with sodium-β-naphthol in the presence of sodium acetate whose function is to neutralise the mineral acid liberated from the diazo and tetrazo compounds.

Two **methods of printing** based upon this principle are employed in practice, namely:

1. A thickened sodium-naphthol solution is printed upon the fabric, which is then passed through a bath containing the diazo compounds (developing bath).

2. The calico is prepared with sodium-naphthol, and the thickened diazo solution is then printed on the fabric.

A third method, which consists in printing the calico with a thickened diazo solution and then developing in a naphthol bath, has not been found useful in practice because the printed diazo compounds partially decompose on drying.

Another method proposed, in order to avoid the preparation of the calico with sodium-naphthol, is to prepare the cotton with sodium nitrite, and to print with a mixture containing the necessary amine, sodium-naphthol, and ammonium chloride; under the influence of heat the ammonium chloride causes the liberation of nitrous acid so that diazotisation and combination take place simultaneously upon the fibre.

By the first method, in which the calico is printed with sodium-naphthol and then dyed in the developing bath, the brightest shades are obtained; in a similar manner, but printing with acid reducing colours on the sodium-naphthol prepared cloth, before developing in the diazo bath, similar effects in the Reserve Style are obtained.

The two processes mentioned are of course primarily intended for producing self-coloured fabrics. The second method, which consists in printing thickened diazo solutions on calico prepared with sodium-naphthol, is employed in the production of patterns containing two or more colours. As a rule it demands the greatest care on the part of the colourist to see that the printing-colours, which are so prone to decompose, are kept as cold as possible, and it is necessary also to work quickly. A few general directions may now be given relative to the preparation and use of the solutions and colours employed in the printing of Azo Colours. The naphthol usually employed as the '**prepare**' is β-naphthol, (α-naphthol being only used in admixture with β-naphthol as a saddening agent for the production of very dark shades); the naphthol is dissolved in water containing sodium hydrate, the solution being then at once used for padding the material, or it is first thickened if intended for printing; sometimes various additions are made to the solution, e. g. Turkey-red oil, castor-oil soap, glycerine, antimonite of soda, gum-dragon, sodium acetate, sodium carbonate, &c.

Certain Azo Colours give much brighter, fuller, and faster colours on a naphthol-oil-prepare, (i. e. a prepare containing sodium-naphthol with an addition of Turkey-red oil or some other kind of soap), than on a simple prepare of sodium-naphthol alone. The best examples illustrative of this point are: para-nitraniline red, and dianisidine-naphthol blue. In the case of para-nitraniline red, gum-dragon may partially replace Turkey-red oil as an addition to the prepare, and it is particularly advantageous if a white resist pattern is required on a red ground.

In many cases, where it is desirable to render the diazo printing-colour as stable as possible, the sodium acetate required to neutralise the mineral acid of the diazo compound is best added to the prepare instead of to the diazo solution, since it is well known that in the latter case the diazo solution does not keep so well. The necessary diazo and tetrazo compounds are produced by the action of free nitrous acid on the salts of amido and diamido bases. The diazotisation of these bases is in most cases best effected in the presence of an excess of acid and in the cold, by one or other of the two following methods:

1. The amido-base is first converted into its hydrochloride or sulphate, and the nitrite solution is allowed to act on the salt in the presence of an excess of acid.

2. The nitrite solution is mixed with the amido-base to form a paste (so-called nitrite-paste) and this is added gradually to the dilute hydrochloric or sulphuric acid.

It is nearly always advisable to use a small **excess of nitrite** (5—10 %), since there is invariably a slight loss of nitrous acid when stirring during the diazotising operation, moreover the presence of a little nitrous acid helps to keep the diazo solutions. The following bases require to be diazotised at a temperature of about 0° C.: **aniline**, the various **toluidines, nitro-aniline, nitro-toluidine**, the two **naphthylamines**, &c.

The following should be diazotised in the cold: **benzidine, tolidine dianisidine, diphenetidine**, &c., whereas the **amido-azo-bases** are best diazotised at 20—40° C. e. g. **amido-azo-benzene, amido-azo-toluene, nitro-phenetidine**, &c.

Metallic salt solutions exercise a considerable influence upon the stability of the diazo compounds, as well as upon the shade of the resulting Azo Colours.

Metallic salts which increase the acidity of the diazo printing-colour, also have the effect in some cases of materially increasing its stability, as for example, an addition of aluminium sulphate to printing-colours containing diazotised p-nitraniline, or an addition of zinc chloride to solutions of diazo-naphthalene or to printing-colours; on the other hand copper salts have in most cases the effect of rapidly decomposing many diazo compounds.

A notable exception and one of some practical importance is furnished by the tetrazo compounds of dianisidine or diphenetidine, which stand the addition of **copper salts** very well indeed. The addition of alkali bichromates to colours containing these compounds even increases their stability.

Of the greatest importance however are the changes produced by the action of **metallic** salts, especially copper salts, on the insoluble Azo Colours; these consist in the formation of new substances possessing a different colour from that of the original compound as well as much greater stability under various influences.

The most important example of this kind is furnished by Dianisidine Naphthol Blue. This colour when produced direct on the fibre from tetrazo-dianisol and β-naphthol is a dull violet fugitive to light, but by the action of copper salts on the azo dye upon the fibre it is converted into a particularly brilliant blue which is faster to light even than indigo.

Nitraniline Red, prepared from the diazo compound of p-nitraniline and β-naphthol, is changed by the action of copper salts into a very fine Havannah brown colour of considerable fastness to soap and light. The following methods of obtaining the beneficial effects due to the action of copper salts may be employed.

1. The azo dye upon the fibre is treated with hot solutions of copper salts.

2. A suitable copper salt is added to the diazo compound.

3. An alkaline copper solution e. g. sodium cupric tartrate is added to the naphthol prepare.

Good results as regards improvement of shade and fastness are obtained by methods 1 and 3, but they are only applicable for self-colours.

The 2nd method however permits of the combination in the same pattern of some Azo Colours which are treated with copper salts and others which are not; for example, the production of blue (Dianisidine Naphthol Blue) in the same print with red (Paranitranline Red) is of great use in styles containing two or more colours, but to effect this it necessary that the diazo compounds used shall not be affected by the addition of copper salts.

Methods 1 and 2 have this defect however, that in the case of prints with white grounds the latter are apt to be soiled through the precipitation of copper compounds.

The following variety of shades is obtainable by producing Azo Colours direct upon the fibre: orange-yellow, orange, orange-red, purple-red, pink, claret-red, blue, blue-violet, red, violet, black, red-brown, yellow-brown, dark-brown.

The only pure colours which are wanting in this list are yellow and green, and for the production of these no suitable amido-bases have as yet been discovered. The **degree of fastness** possessed by the insoluble Azo Colours, may be considered good, it is well to add however that in this respect very considerable differences are exhibited by the various colours.

Paranitraniline-red is for example much faster to light and to washing than is β-naphthylamine-red. As already stated, Dianisidine Naphthol Blue is particularly fast to light and stands boiling with soap very well, but it is not so fast towards the action of perspiration or a treatment with hot soda solutions.

The simplicity and rapidity of their production, together with their brilliancy and comparative fastness, are all factors which have undoubtedly contributed to secure for the Direct Azo Colours their general adoption in calico-printing, notwithstanding the existence of certain difficulties connected with their production, due to the peculiarities of the substances employed.

The difficulties alluded to are as follows:

1. The instability of the naphthol-prepare under the influence of light and air.

2. The tendency of the diazo compounds to decompose, a fact which necessitates the use of considerable quantities of ice, not always readily obtainable.

With respect to the first point, it is well known that calico impregnated with alkaline solutions of naphthol rapidly becomes brown on exposure to light as well as under the influence of air and heat. This defect is experienced in an annoying manner whenever naphthol prepared goods are allowed to lie too long before printing. In this case the brown decomposition products of the naphthol are partially fixed upon the fibre, with the result that the colours are rendered dull and the white is considerably soiled.

The defect can be counteracted by adding to the naphthol-prepare a solution of **antimonite of soda** containing glycerine. Cotton goods impregnated with antimony-naphthol-prepare remain white for weeks, the colours produced on this prepare, however are not quite as brilliant.

The fact that this addition increases the cost of the naphthol-prepare, as well as the circumstance that printers have become accustomed to work off the prepared goods quickly, will undoubtedly have the effect of limiting the employment of the process.

The difficulty sometimes experienced, of carrying out the diazotising process in a satisfactory manner, owing to the ready decomposition of the diazo compounds, is also a

serious defect which militates against the general adoption of the method of producing the Azo Colours direct on the fibre. In this connection the recent discovery of the Azophor colours is a distinct advance in the technology of colouring matters.

VI. Mordants and their employment in Printing.

Among the various assistants used in dyeing and printing the so-called mordants occupy a prominent position, since their function is to fix the Mordant Colours on the fibres; and owing to the fastness of the colour-lakes produced by their means, they have naturally become of considerable importance.

The formation of a colour-lake depends essentially upon the chemical combination of colouring matter with the mordanting substance, so as to produce a more or less insoluble precipitate. In its widest sense the term 'mordant' refers to all substances which in conjunction with colouring matters produce lakes, e. g. aluminium and chromium salts, tannic acid, potassium ferro-cyanide, &c. In its narrower sense however the term refers specially to metallic salt solutions capable of forming with the Mordant Colours insoluble compounds or 'lakes', in which the colouring matter plays the part of an acid.

The behaviour of the mordants towards the different **Textiles fibres** exercises a considerable influence upon the formation of the lake. It is well known that the animal fibres wool and silk have the power of attracting the mordanting oxides from the mordant solutions, a process which may be partly of a chemical and partly of a mechanical nature (surface attraction); under other conditions the same property is shown by the vegetable fibres, for example, cotton is capable of decomposing normal and, better still, basic aluminium salts, and fixing a certain amount of aluminium hydrate. This power of attraction increases with the degree of dilution and the temperature of the mordanting solution, as well as with the duration of the mordanting process. In a similar manner prolonged contact of the cotton fibre with an alkaline solution of chromic hydrate effects decomposition of the latter and the fibre takes up large quantities of chromic hydrate. If ferrous salts are employed, one must also take into account the oxidising action of the air whereby the ferrous salts are changed into unstable ferric compounds.

The mordanting process is assisted and completed by subsequently passing the mordanted goods through the so-called fixing baths. Sometimes mordants may exercise an injurious action upon the textile fibres, as for example in the following cases:

1. **The acids liberated during the fixing process may tender the fibres,** hence, in order to avoid this corrosion, acetates or basic acetates are employed, especially when printing with steam-colours.

2. **The deposition of the mordanting substance** upon or within the fibre may make it brittle and cause it to break.

3. The fibre may experience a deep seated **chemical change,** e. g. by the formation of **oxycellulose.**

For the purpose of printing, mordants are employed in two different ways:

1. in Dyed Colours
2. in Steam Colours.

This subject will be treated of in detail in the chapter on Mordant Colours, our present object is merely to consider the preparation, properties, and use of mordants. Those usually employed, and named according to their chemical composition, are as follows:

Aluminium, iron, chromium, tin, zinc, nickel, calcium, magnesium, &c., mordants. Of these the first three on the list are by far the most important, while the rest, more particularly the lime and magnesia mordants, are rather to be regarded as assistant-mordants.

A. Aluminium Mordants.

Among all the mineral mordants available, those of aluminium have found the earliest and most extensive employment, because they are capable of yielding the finest and fastest colour-lakes. No doubt this has been largely owing to the facility with which they can be applied and because of the well marked tendency to dissociation shown by the aluminium salts. This property of dissociation, which consists in the decomposition of the aluminium salts with the formation of insoluble aluminium compounds (aluminium hydrate and very basic aluminium salts), is materially affected by several factors, e. g. the degree of **dilution**, the **basicity** of the mordant, the **temperature**, the **duration** of the mordanting operation, as well as the nature of the fibre; the latter plays an important part, more particularly in the case of dyed goods. The aluminium mordants are most extensively employed in calico-printing; they are as a rule basic salts in which the alumina is combined with sulphuric, acetic, hydrothiocyanic, and nitric acid, and occasionally with hydrochloric and sulphurous acid, either alone or mixed together. They may therefore be classified as basic sulphates, normal and basic hydrothiocyanate-acetates, normal and basic acetates, normal and basic hydrothiocyanate-acetates or sulphates, nitrate-acetates, &c.

The methods adopted for their preparation may be as follows: **1. double decomposition, 2. direct neutralisation of the normal salts** with alkali hydrates or carbonates, chalk, &c. **3. dissolving aluminium hydrate or alkali-aluminium-carbonate** in the necessary acids.

The original materials employed for preparing the aluminium mordants are aluminium sulphate, the various alums, aluminium hydrate derived from the latter, or alkali-aluminium-carbonate.

Since the shade of an alumina-lake is affected by mere traces of iron, it is of the utmost importance to ascertain that the materials employed in the manufacture of aluminium mordants are as free from iron as possible. In order however to counteract the injurious action of traces of iron compounds, the presence of which cannot indeed be entirely prevented, either during the preparation of, or the printing with, alumina colours, e. g. by the use of steel doctors, it is of the greatest advantage to use the hydrothiocyanate of alumina (sulphocyanide), which through the formation of ferric thiocyanate prevents the injurious effect of the iron. A small addition of yellow prussiate of potash to the ordinary aluminium mordants acts in a similar manner by precipitating and rendering inert any traces of iron present.

For the purpose of double decomposition it is usual to employ in conjunction with the aluminium sulphate, &c., lead, barium, and calcium salts, more particularly the acetates, hydrothiocyanates, nitrates, &c., which by the formation of insoluble or sparingly soluble sulphates effect the exchange of acetic acid for sulphuric acid. The details regarding the preparation of the most important aluminium mordants will be given in the chapter dealing specially with the printing and dyeing of alizarin-red. In the printing of steam-colours on calico the acetates and hydrothiocyanates are most frequently employed, since the corrosive action of non-volatile acids debars their use, but in the case of wool it is quite customary to employ even strongly acid aluminium salts, e. g. sulphates, and indeed their acidity is sometimes still further increased by the addition of a certain amount of sulphuric, tartaric,

or oxalic acid, &c. since some colouring matters are only capable of being fixed on wool from a strongly acid medium.

Alkaline aluminium mordants, e. g. aluminate of soda, are only used for cotton in special cases, e. g. as resists for acid covers (aniline black, &c.) in printing, and as the mordant in the so-called Schlieper and Baum Alizarin-red process. An aluminium compound still less frequently employed is the chlorate of alumina, which is used for discharge-colours on indigo.

B. Iron Mordants.

These mordants also find extensive employment in calico-printing. The iron-lakes of the Mordant Colours under consideration are notable for possessing full dark shades, and being sometimes of extraordinary fastness they are employed both in printing and dyeing. Those most frequently used are the ferrous salts, more particularly the normal and basic acetates, and the sulphate-acetates.

In dyed goods the fixing of iron mordants takes place through the formation of easily dissociated oxidation products during the ageing process, the oxidation being regulated by making certain additions to the mordant.

The commonest iron mordant employed is ferrous acetate, which is prepared either by double decomposition, or as pyrolignite of iron by dissolving iron turnings in pyroligneous acid; other iron mordants in use are ferrous sulphate-acetate, red and yellow prussiate of potash, and very occasionally the ferric salts.

C. Chromium Mordants.

The chromium mordants have only come into prominent use through the development of the coal-tar colour industry, since very many of the artificial colouring matters can only be fixed with sufficient permanence by means of chromic oxide salts.

With few exceptions, the dissociation of the chromium mordants with respect to cotton is not so strongly marked as in the case of the aluminium and iron mordants, and this circumstance is the real cause why the practical application of chromium salts for the production of dyed styles in calico-printing is only of comparatively resent date. The most useful chromium salts for this purpose are: chromite of soda, chromium-chromate, chromium bisulphite and to some extent also basic chromium chloride. The property possessed by **chromite of soda**, i. e. a solution of chromic hydrate in caustic soda, of readily giving up its chromic oxide to the cotton fibre by a mere steeping process, not only almost completely but also in a form in which it is easily dyed, has been the means of developing to a high degree of perfection the so-called **chrome dyed goods.** These dyes are remarkable for their fastness, hence as soon as the initial difficulties connected with working in strongly alkaline liquids had been overcome, they acquired great importance in calico-printing. The **chromium-chromate mordants**, e. g. basic chromium-chromate, chloride, or chromium-chromate-acetate, are also remarkable for the readiness with which they yield their chromic oxide to the cotton fibre. They are employed with advantage in the production of dyed goods because of the beauty of the dyes they yield, and the low cost of their production.

The presence of chromic acid causes the mordant to be sensitive to light, a circumstance which must always be borne in mind during their employment.

The chromium bisulphite mordant also gives up a satisfactory amount of chromic oxide to the cotton fibre, but the sulphurous acid which escapes during the drying operation is a considerable nuisance. The foregoing chromium mordants yield most of their chromic oxide to the fibre without the application of any fixing agents, but those now to be mentioned e. g. the basic chloride, and the basic sulphate and acetate, require the use either of somewhat concentrated hot alkaline fixing baths, or of Turkey-red oils and tannin matters, in order to fix the mordant satisfactorily.

The most important chromium mordants for steam-colours are the **chromium acetates,** viz: 1. the green coloured normal acetate, and 2. the violet coloured basic acetate.

The behaviour of these two modifications is somewhat different and will be discussed when the colouring matters are under consideration. Chromium acetate has the very remarkable property that in the cold it is not precipitated by ammonia or at least only with difficulty, and frequent use is made of this fact in the preparation of padding-colours, which contain an ammoniacal solution of the colouring matter along with chromium acetate.

Chromium chlorate, prepared by double decomposition, is employed in steam-colours, whenever an oxidising action is required in addition to the fixing of the colouring matter, e. g. in steam-colours which contain Alizarin Colours and Catechu (chromium-nitrate-acetate). Chromium sulphite is used in steam-colours containing bisulphite colouring matters, e. g. the sodium bisulphite compounds of Alizarin Blue, Ceruleïn, Alizarin Green, &c.

A characteristic property exhibited by the chromium mordants, as compared with those of aluminium, is that in most cases they are capable of forming fast colour-lakes, without the aid of certain assistant mordants, e. g. calcium acetate, when printing alizarin-red.

Acid chromium mordants are employed in **wool-printing** e. g. chrome alum, chromium fluoride, and chromates the first named salt is generally used with the addition of oxalic, tartaric, and sulphuric acid.

D. Tin Mordants.

The tin mordants are usually employed in admixture with other mordants, for example those of aluminium, sometimes as **stannous** salts, sometimes in the form of **stannic** salts.

The stannous mordants are largely employed in **Discharge** and **Resist Colours,** the application of which will be dealt with in a special chapter. In certain discharge-colours, which contain tin-crystals mixed with Basic Colours, the tin serves not only for discharging the dye but also for fixing the tannin-lake.

It is worthy of note that up to the present no artificial colouring matter is known which can be satisfactorily fixed by means of tin compounds alone (like Persian berry carmine). Some of the tin compounds are very useful as assistant mordants e. g. stannous nitrate-acetate, oxalate, and thiocyanate (sulphocyanide), also certain insoluble oxides of tin e. g. stannic oxide, and oleate of tin, which are employed in the form of precipitates partly in dyeing alizarin-red, partly as additions to steam-colours.

E. Nickel, Zinc, and Cobalt Mordants.

Like the tin mordants these find at present only a limited use for steam-colours, in the form of acetates or sulphites. In point of fastness the lakes they yield are much inferior to the chromium lakes, although they usually excel the latter in brilliancy of colour.

F. Calcium and Magnesium Mordants.

These act essentially as assistant-mordants, and the calcium compounds, more especially, play a very important part in the production of aluminium lakes on cotton by means of the Alizarin Colours. In the case of Alizarin itself, for example, it is only by introducing lime into the complex molecule of the aluminium lake that the fastest and most fiery red is obtained. The most important calcium mordant is calcium acetate, which is prepared from pure lime free from iron. Now and then calcium chloride and calcium thiocyanate are also used.

Magnesium mordants are seldom employed and at most only as additions to steam-colours containing chromium mordants.

In conclusion a brief reference may be made to a few other metallic salts used in calico-printing, which are frequently of considerable importance, although they take no direct part in the lake-formation.

To this class belong, for example, the copper salts, which in oxidation processes act as carriers of oxygen, e. g. in the Aniline Black process, where copper sulphide or thiocyanate is employed, or in the fixing of catechu colours, as well as in the resist-indigo-paste style, in which nitrate of copper is much used.

In the Aniline Black process, vanadium and cerium compounds are sometimes employed in place of copper salts.

G. Copper mordants.

The employment of copper salts as mordants in connection with certain artificial colouring matters, e. g. Dianisidine Naphthol Blue, &c. has been quite recently introduced. The copper enters into the composition of the colour-lake, and not only effects an improvement in the shade but also makes the colour very much faster to light, an effect which has also been noticed in the case of certain tannin colour-lakes after treatment with copper salts.

The copper salts employed are the sulphate, chloride, and acetate-nitrate, or mixtures of these.

VII. Thickening agents and their employment in printing.

Solutions of colouring matters and mordants can only be applied in printing when they have been thickened by means of certain so-called thickening materials; these agents are used in order to give the necessary adhesiveness and viscosity to the printing mixture so that it may be held in sufficient quantity by the engraving of the printing roller, they also prevent the colours when printed on the fabric from running.

Hence the action of the thickening material is to diminish the capillary attraction which exists between the fibre and printing mixture, whereby the greatest possible sharpness and neatness of impression is secured.

The substances used for the preparation of thickenings are chiefly organic, such as certain carbo-hydrates and gums; less frequently inorganic substances are employed, e. g. aluminium hydrate, barium sulphate, pipe-clay, &c., their chief use being as a rule to strengthen the action of the organic thickening agents, and in certain cases to act as mechanical resists.

The following **organic thickening materials** are largely used:

1. **Starch** of various kinds, (wheat-starch, potato-starch, rice-starch, &c.).

2. **Flour**; this contains in addition to starch, certain nitrogenous substances (gluten).

3. **Dextrine** and products containing dextrine derived from various kinds of starch, e. g. light and dark roasted starch, gum substitute, British gum, artificial gum, &c.

4. **Gum Tragacanth**, ('Gum-dragon').

5. **Gums** of different qualities and varied origin; some like gum-arabic and gum-senegal are readily soluble, while others require to be submitted to the action of super-heated steam, with or without the addition of acid.

6. **Albumin and Caseïn.** These nitrogenous substances of animal origin have the property of being coagulated and rendered insoluble under certain conditions, hence they are well adapted for fixing insoluble pigments (ultramarine, vermilion, chrome-yellow, &c.).

Solutions of albumin, caseïn, gum, and dextrine, may be prepared in the colde especially albumin), since they already posess naturally the necessary adhesiveness; starches however, being insoluble in cold water, must be converted into starch-paste by heating with water to a temperature of at least 68° C (155 F).

It is possible however, by means of caustic alkalis, to thicken starch even in the cold, and to prepare from it a powerful thickening called 'aparatine'; mixed with roasted starch this is used for strongly alkaline discharge-colours. By neutralising the aparatine with acids, or even using excess of acid, it is possible to prepare in the cold, both neutral and acid starch thickenings.

The **choice of thickening agents, and the preparatian of the thickening** require special care, for both have a very considerable] influence in determining the excellence of the prints ultimately obtained.

Wheat-starch and flour, for example, can be very readily thickened by boiling for a short time only, with water or dilute acetic acid, whereas gum tragacanth requires to be well steeped in warm water, and in addition has often to be boiled for 12—24 hours, in order to obtain a perfect thickening. The different kinds of natural gums are also first softened by steeping in water and then boiled for a considerable time; the so-called Indian gums, which are only sparingly soluble, are boiled under pressure with or without the addition of acids and hydrogen peroxide. Albumin is always dissolved in cold water, to avoid coagulation, caseïn is usually dissolved with the addition of ammonia, borax, &c.

In order to prevent the thickenings from decomposing so that they may be kept for some time, additions are made of acetic acid, salicylic acid, turpentine, &c.

There are **two methods of using thickening agents,** one is to make the thickening separately and then to add to it the liquids which require to be thickened, the other is to add to the latter the necessary thickening agent and then to dissolve it either in the cold or by boiling.

The qualitative and quantitative action of the various thickening agents is very different, it is well known for example, that wheat-starch and flour posses greater thickening

power than gum tragacanth and gum senegal, and that colours thickened with the former are darker and fuller than with the latter, but not so even and bright. When printing with mordant solutions the thickening also play sa very important rôle; gum senegal and dextrine, for example, retard and even partially prevent the complete fixation of mordants, more particularly iron mordants.

Important differences are also observed in the behaviour of thickenings towards acid, alkaline, oxidising, and reducing agents, and with respect to their power of resisting any tendency to run during the operation of steaming; they vary also in the facility with which they can be removed by the subsequent operations of washing and soaping; hence it is that the proper choice of thickening agent is of the greatest importance.

METHODS

OF

FIXING COLOURS BY PRECIPITATION.

(THE MANUFACTURE OF LAKES AND THE COLOURING OF PAPER.)

The Methods of Fixing Colours by Precipitation.

The method of precipitating colouring matters in the form of insoluble compounds i. e. **Lakes,** used in the **manufacture of Pigment Colours** required for lithography oil and water-colour painting, wall-paper printing, and the colouring of paper. In all cases the principle of the fixing process consists in precipitating the colouring matters from their solutions in an insoluble form and with as brilliant a colour as possible; in most cases a white or only slightly coloured substance — the so-called 'sub-stratum', 'base' or 'filling' — is dyed by the precipitated colouring matters, or the 'base' itself is produced simultaneously with the precipitation of the colouring matter.

This precipitation is effected as follows:

A. **By dyeing** a white or pale coloured sub-stratum, in which case, as in the dyeing of textile fibres, there comes into play a decided affinity which exists between the colouring matter and the substance to be dyed.

B. **By precipitation**; here the addition of a solution of one or more precipitating agents throws down the colouring matters in an insoluble form from their solution by way of double decomposition.

These two methods cannot however be distinguished from each other by any sharp line of division, for in practice many cases occur in which both are employed simultaneously, especially when full deep colours are required, the substratum having too little affinity for the colouring matter to give the requisite depth of colour, and also in the case of those colour-lakes in which one colouring matter fixes or precipitates another.

A. The Production of Pigment Colours by Dyeing.

In order to produce pigment-colours by the process of dyeing, one method is to mix with water certain **natural** 'bases' or 'substrata' which have the property of attracting and fixing colouring matters, and then to add the colour solutions; the other method is to prepare such insoluble substrata artificially, and then to dye these with the necessary colour solutions.

Of the natural materials which are useful for the above purpose may be mentioned: Green-earth, Bolus, Ochre, Alumina-earth, Kaolin, China-clay, Infusorial-earth, Gypsum Calcspar, and Chalk. In the manufacture of Pigment Colours these may be employed for fixing in a direct manner such colouring matters as are given below.

Green-earth, alumina-earth, kaolin, China-clay, infusorial-earth, ochre, and bolus, all fix Basic Colours. If one or other of these substances, suspended in water in a fine state of subdivision, be mixed with the solution of a basic colouring matter, the latter is attracted by the insoluble material, and indeed so energetically, that it is impossible to remove it again even by boiling with different solvents. In these substrata, it would appear that the silicic acid which they contain plays the chief part, namely by forming insoluble silicates of the colour-bases, or by the insoluble silicates attracting the colouring matters so as to form double silicates. The colouring matters chiefly employed for this purpose are: Brilliant Green, Malachite Green, Magenta, New Magenta, Methyl Violet, and Auramine, also Methylene Blue, Methylene Green, Vesuvine, Safranine, and Chrysoïdine. The method of fixing is very simple: the material to be dyed is suspended in water, the necessary colour solution is then added with continual stirring, until the desired shade is obtained; the lake which is thus obtained is allowed to settle, then separated by decantation, pressed, and dried.

In most cases the fixation is quite complete even at the ordinary temperature, but brighter colours are sometimes obtained by heating or even boiling; if however the material to be dyed contains carbonate of lime or magnesia as well as silicates, it is not advantageous to heat the mixture, because this tends to precipitate the colour-bases, and since these are either colourless or only slightly coloured, loss of colouring matter may thus take place. In such cases a slight addition is made of some acid, e. g. hydrochloric, sulphuric, or acetic acid. — Sometimes the fixing power of the substratum is insufficient, and it is found necessary to complete the precipitation by making an addition of tannic acid, soap, resin-soap, or bichromate of potash.

As a rule the Basic-Colours are sparingly soluble and they are decomposed by the carbonates of lime and magnesia contained in the water, with the separation of the colour-bases, usually in a resinous form. Hence, for dissolving the bichromate of potash, it is desirable to use non-calcareous water, e. g. condensed water, the colouring matters being then added at a temperature of 70—80° C. (160—175° F.) the mixture being well stirred; as a rule the colouring matter requires 250 times its weight of water to dissolve it properly. If no condensed water is at command, it is customary first to pour over the colouring matter about five times its weight of acetic acid 12° Tw., and then to add hot water (70—80° C., 160—175° F.) gradually till the solution is complete. Another method which may be recommended is to stir the colouring matter to a paste on the water-bath with two parts of anhydrous glycerine and four parts of alcohol, and then to dissolve in hot water.

Chalk, gypsum and calcspar are able to fix partially certain Acid and Azo Colours, by precipitating the colour-acids as insoluble lime salts. Specially suitable for this method are: Acid Violets N and 5 B F, Patent Blue A, Claret, Azo Yellow, and Fast Red O, although as a rule only pale colours can be obtained, because the fixing power of the above agents is too limited. If full deep colours are required it is necessary to make a further addition of more suitable fixing agents.

The Mordant Colours are fixed on artificially prepared substrata by the process of dyeing. As a rule insoluble alumina-substrata are made from aluminium hydrate mixed with varying amounts of phosphate of alumina, lime, stannous, stannic, and iron compounds. If these insoluble substrata, suspended in water, are mixed with the Mordant Colours, the

colour-acids of the latter combine with the metallic hydrates, aluminium hydrate being the one which comes chiefly into play, if not entirely.—Owing to the sparing solubility of most of the colour-acids, as well as the insolubility of the substrata, the formation of the colour-lakes by the combination of the colour-acids with the metallic hydrates takes place gradually and only on boiling, exactly as in the dyeing of the textile fibres.—As a rule the substratum is suspended in water and the colouring matter is added in the form of a thin paste with constant stirring, the mixture is then slowly heated to the boiling point and the boiling is continued until the formation of the lake is complete. Very frequently, certain additions e. g. Turkey-red oil, acetate of lime, &c., are made previous to heating, for the purpose of shading, or for making the lake brighter.

This method is employed with Alizarin Red paste, Alizarin Orange G and N paste, Azarin S, Galleïn paste, Coeruleïn paste, also with Alizarin Claret R, Alizarin Brown paste, Alizarin Yellow G G, R, and Alizarin Blue, as well as with certain natural colouring matters. Specially important are the red and pink 'madder-lakes' prepared from Alizarin Red, these being largely used in lithography and painting, because of their great fastness to light. In the case of these madder-lakes, the substratum consists chiefly of aluminium hydrate (containing a little sulphuric acid) and phosphate of alumina, while the dye-bath is charged with Alizarin (1 B new, for blue shades, R X for yellow shades of red), Turkey-red oil, and acetate of lime.—The Azarin lakes, comprising red and pink lakes of extreme beauty, are prepared by dyeing substrata containing alumina and tin, with Azarin S and Turkey-red oil; they are used for lithographic work.—In order to obtain the most brilliant reds and pinks when making the madder and azarin lakes, great care must be taken to avoid the presence of iron, not only in the materials but also in the water and the apparatus employed.

Another mode of preparing lakes by means of Mordant Colours will be given in the next chapter.

B. The Production of Pigment Colours by Precipitation.

In the manufacture of colour-lakes various precipitation methods are much more frequently employed than the dyeing method.—Although the number of colouring matters used in the manufacture of pigment-colours is comparatively small, since so few possess the necessary property of being readily and completely precipitated, and with a sufficiently brilliant shade, still, the methods of precipitation in vogue are somewhat numerous. What particular agent must be selected to effect the precipitation depends chiefly upon the nature of the colouring matter employed, but the choice varies also according to the purposes for which the pigment-colour is intended.

According to the nature of the colouring matters employed, the methods of precipitation in use may be classified as follows:

I. Precipitation methods for Basic Colours.
II. Precipitation methods for Resorcine Colours.
III. Precipitation methods for Azo and Acid Colours.
IV. Precipitation methods for Mordant Colours.

I. The **Basic Colours** usually employed are as follows: the various brands of Magenta, Cerise and other low class magentas, Grenadine, Maroon, New Magenta O, Methyl Violet, Brilliant Green, and Malachite Green, further, Auramine, Safranine, Rosolane, Vesuvine

Methylene Blue and Methylene Green. They are precipitated by one or other of the following five methods.

1. Precipitation with **Tannic Acid** on various substrata is carried out by first suspending the substratum in water, then adding the solution of colouring matter, and finally the tannic acid solution, with constant stirring; in this manner the colour-bases are precipitated as insoluble tannates in a fine state of subdivision. The nature of the substratum plays an important part in the process, since it assists the precipitation to a greater or less extent, hence according to the substratum employed the amount of tannic acid to be employed may vary considerably.—In many cases, particularly when using substrata of an indifferent nature e. g. sulphate of barytes, blanc-fixe, &c., the precipitation is rendered more complete by making an addition of sodium acetate (rarely sodium carbonate), in order to neutralise the acid of the colouring matter employed.—For many purposes, especially when it is desired to make lakes suitable for lithographic varnishes, the precipitation is effected with tannic acid and tartar emetic.—In all cases where lakes are precipitated by means of tannic acid care must be taken that the materials employed are free from iron, otherwise the formation of gray coloured tannate of iron will materially diminish the brilliancy of the lake.

2. Precipitation with **Soap** on various substrata is effected by first suspending the substratum in water, then adding the solution of the necessary colouring matter and finally a solution of soap; the latter (usually Olive oil soap) is added in a thin stream with constant stirring, the whole mixture being at the same time gradually heated to the boiling point. In this process, double decomposition takes place, and there are formed insoluble compounds of the colour-bases with oleïc, stearic, or palmitic acid; these envelop or permeate, and thus dye, the particles of the white material and so tend to impart brilliancy to the lake.—For complete precipitation it is necessary to employ about equal parts of soap and colouring matter.—The soap used must on no account be alkaline, otherwise serious loss of colouring matter and diminished brilliancy will result.—For many colouring matters Turkey-red oil is employed instead of soap.

3. **Resin-Soap** is capable of readily precipitating all Basic Colours, both completely and with the production of brilliantly coloured lakes. The substratum to be dyed is suspended in water, the colour solution is added, and the solution of resin-soap is then added with constant stirring, the whole being gradually heated to the boiling point; finally an addition of sulphate of zinc or alum is made in order to complete the precipitation, the whole being then allowed to cool while continually stirring the mixture.—The resin-soap is prepared by boiling a mixture of the following ingredients until a clear solution is obtained, and then making up the whole to 1 gallon.

1 lb. Resin		1 lb. Resin
4 oz. Soda	or	2 oz. Soda
1 gall. Water		1 gill. Caustic Soda $32^{1}/_{2}$—$33^{1}/_{2}$° Tw.
		1 gall. Water.

For precipitating 2 oz. Basic Colours there are required about 10 oz. resin in the form of resin-soap and 3.5 oz. sulphate of zinc.—In this process there are produced the insoluble double resinates of colour-base and zinc (or aluminium). Care must be taken to stir the mixture very well during the progress of the precipitation, otherwise the colour-precipitate readily separates from the substratum. The resin-soap lakes thus obtained are used in wall-paper printing and paper staining, but only for papers having a matt surface since they do not stand glazing.

4. **Albumin** and **Caseïn** may also be employed for precipitating basic colouring matters.—The usual plan adopted is to suspend the substratum in a dilute solution of the

colouring matter and then to add an ammoniacal solution of the caseïn previously prepared in the cold. The mixture is heated to the boiling point so as to complete the precipitation by causing the coagulation of the precipitating agent.

5. **Phosphate of soda,** namely the tri-acid phosphate, finds a special use in the preparation of brilliant violet lakes from Methyl Violet. In this case the substratum must contain aluminium hydrate, since the principle of this method of precipitation depends upon the formation of a double phosphate of alumina and colour-base. The precipitation is not very complete, hence it is found necessary to allow the mixture to stand for a considerable time.—In addition to phosphate of soda, other inorganic precipitating agents employed are silicate of soda, and bichromate or neutral chromate of potash.

II. The **Resorcine Colours** play a very important part in the manufacture of pigments; the colouring matters usually employed for this purpose are the different marks of Eosine, and for reds and pinks, the bluish-red colours of this group, namely, Erythrosine, Phloxine, and the various brands of Rose Bengale.—The precipitating agents almost exclusively employed are the **nitrate** and **acetate of lead,** which by way of double decomposition produce so-called lead-lakes, i. e. insoluble lead compounds of the colour-acids of the Eosine Colours; these lakes are precipitated in admixture with the substrata employed, and are remarkable for their extreme beauty and brilliancy. The substrata most frequently in use are: orange-minium, heavy-spar, blanc-fixe, sulphate of lead, white lead, alumina, and mixtures of these substances; less frequently employed are kaolin, China-clay, starch &c.—The Eosine Colours are very sensitive to acids, so that the shade of an Eosine-lake is even influenced by the more or less acid reaction of the substratum, by the end reaction of the mixture, as well as by the nature of the insoluble inorganic substances produced by the precipitation.—Hence from one and the same Eosine it is possible to obtain a variety of yellow or blue shades of red by slightly altering the substrata or other additions.—Since the Eosine Colours are readily soluble no particular precautions need be taken when dissolving them.

The **Basic** Colours may also be employed as precipitating agents for the Eosine Colours, since the compounds of the colour-bases of the former with the colour-acids of the latter are not only insoluble in water, but are also very brilliant in colour. Complete precipitation is however never obtained unless the colours are used together in strict molecular proportions. This method is employed for producing Eosine-lakes free from lead on substrata of an indifferent character. In practice Magenta and Rhodamine are used for brightening or shading Eosine-lakes, the precipitation being completed by an addition of lead salts. (See also below.)

III. Acid and Azo Colours. Numerous colours belonging to these two classes are at command, and yet comparatively few are employed on the large scale for making pigments, because so many of them are not useful, owing to their great solubility and the dull colours of the precipitates they yield.—The precipitating agents chiefly employed are as follows:

1. **Lime salts,** usually calcium chloride and occasionally calcium acetate; these are used to a limited extent in conjunction with certain Azo Colours, especially Scarlets, instead of the dearer barium chloride, for the production of the commoner qualities of lakes; they are chiefly employed when the material to be coloured contains lime, which would necessitate the use of a relatively larger amount of barium chloride. Chalk, gypsum (natural or artificially prepared) are often coloured with Scarlet, Claret, Fast Brown, Orange, &c.; with these colouring matters lime salts must be used as the precipitating agent; calcium chloride is also used in the manufacture of very cheap imitations of vermilion.

2. **Barium chloride** is one of the most important precipitating agents, and it is only occasionally replaced by barium acetate or nitrate. With most of the Acid and Azo Colours employed in the manufacture of lakes, it yields insoluble or sparingly soluble compounds, and these are precipitated under the influence of the substratum, and occasionally also by reason of the formation of double compounds. An essential feature in this process is the occurrence of double decomposition, whereby the brightly coloured barium salts of the colour-acids, as well as sodium chloride (occasionally calcium or ammonium chloride), are produced.—In the case of many of these barium-lakes, great importance is attached to the nature of the substratum employed or formed during the process, its more or less acid reaction, the accidental or intentional presence of impurities, &c.—When precipitating with barium salt (and indeed in all cases of lake manufacture), a far reaching influence is also exerted upon the brilliancy, depth of colour, and shade of the lakes produced, by such factors as, the temperature at which the precipitation is effected, the concentration of the solutions employed, the order in which they are mixed with each other, the duration of the mixing process, the manner in which the stirring is done, &c.—Special attention is here only directed to the influence of temperature in the case of some sparingly soluble Azo Colours e. g. Orange II, Brilliant Orange R, certain yellow shades of Patent Scarlets, Fast Red O, &c. At the ordinary temperature these colouring matters readily give poor, weak, dull coloured lakes, especially when the solutions are somewhat concentrated, because they are then partly thrown out of solution as sodium salts, and on the addition of barium chloride each particle of the precipitate thus produced becomes only superficially covered with a layer of insoluble barium salt; in this manner the formation of the barium compound is rendered incomplete, and the substratum is not coated with a brilliantly coloured barium-lake.—At a higher temperature however, especially at a boiling heat, brilliant and deep coloured lakes are obtained, for in this case the colouring matter remains in a state of perfect solution, and is only gradually rendered insoluble as the precipitating agent, i. e. the barium chloride solution, is added; thus the whole of the colouring matter is utilised and, being precipitated upon the substratum in an exceedingly fine state of subdivision, the maximum depth of colour is obtained.—The following colouring matters are those which are chiefly precipitated by the barium chloride method: Naphthol Yellow S, Azo Yellow O and conc., Orange IV, L and LL, Victoria Yellow, Fast Brown, Orange No. I and No. II, Brilliant Orange O, G, R, the various Scarlets, Paper Scarlet, Claret; further, the following Azo Colours, Orange G, Fast Red O and S, Scarlet 5 R and 6 R, Azo Black O, Naphthol Black D, and the following Acid Colours, Soluble Blue, Lyons Blue, Cotton Blue, Alkali Blue, Pure Blue, Fast Blue, Acid Green, Patent Blue V, L, superfine, and A, Ketone Blue 4 B N solution, Acid Violet N, 5 B F, 7 B N; further also, Acid Magenta, Acid Violet 4 R S, and 3 R S, and Fast Acid Violet.—As to the substrata employed in connection with the barium chloride method of precipitation, the most various kinds are in use, although certain very soluble colouring matters, e. g. Patent Blue V, L, and superf., the red shades of Acid Violet, and Acid Magenta, are only employed in conjunction with a substratum containing aluminium hydrate, and which is free from alkali and alkali salts.

3. **Nitrate, Acetate, and Basic Acetate of Lead** are often used as precipitating agents for Acid and Azo Colours, though less frequently than barium chloride, partly because of the more poisonous character of the lead compounds, partly because lakes which contain lead are sensitive to the action of hydrogen sulphide, and become brown through the formation of dark brown coloured lead sulphide, whenever they are exposed to the action of air in which this gas is present.—On the other hand lead salts are preferred to barium salts as precipitating agents, whenever the material to be coloured itself contains lead, and especially when the Acid and Azo Colours are employed in combination with the Eosine Colours.

4. In addition to the above mentioned precipitating agents, the following are employed in special cases for certain Acid and Azo Colours: alum, chrome-alum, stannic chloride, stannous chloride, sulphuric acid, &c. In some cases, and with certain colouring matters, these give specially good results, but they have never found general employment.

IV. The **Mordant Colours** may also be used for the manufacture of colour-lakes by the precipitation method; the principle of this method consists in making a solution of an alkali salt of the colouring matter, and then adding to it the solution of some suitable metallic salt, whereby a precipitate is thrown down, which consists of the colour-acid combined with the metallic oxide of the salt employed.—Alum is the metallic salt almost exclusively selected for the purpose, so that the lake obtained is the alumina compound of the colour acid employed; in most cases Turkey-red oil and lime salts are used in addition, since these, by entering into the composition of the lake, materially increase the brilliancy of its colour, indeed, in the case of some colouring matters their employment is absolutely necessary for the production of good colours. With the Azarines, tin compounds, e. g. stannate of soda, are used in addition to alum and Turkey-red oil.—The substratum is produced simultaneously with the colour-lake, a fact which adds materially to the brilliancy of the lakes obtained by this method.—The precipitation may be effected in the cold, but the formation of the lake is then very incomplete, perfect lake formation being only brought about by raising the temperature to the boiling point and continuing to boil for a short time, so that the principle of this method is partly precipitation and partly dyeing. A useful method for most Mordant Colours is the following:

Colouring matter, 1 : 10	70	measures
Phosphate of soda, 1 : 20	300	,,
Soda solution, 1 : 10	40	,,
Turkey-red oil (50 %) 1 : 10	40	,,
Alum solution, 1 : 20	500	,,
Lime-water, 1 : 30	10	,,

Dissolve the first four ingredients together, and with continual stirring add to the alum solution, and finally add the lime-water; the mixture is then heated to the boiling point with continual stirring, and the whole is boiled for 1 1/2 hours. The precipitate is washed with hot water till perfectly free from salt, and the lake is obtained by filtering, pressing, and drying. The following colouring matters are treated in this manner: Alizarin Red (various marks), Alizarin Orange, Alizarin Brown, Alizarin claret R, Alizarin Yellow G G and R, Ceruleïn, Galleïn, Alizarin Blue, Acid Alizarin Blue B B and Acid Alizarin Green G, Alizarin Green S, &c.—By making small alterations in the proportions of the different ingredients, as well as by adding certain other ingredients for shading purposes, such as iron and tin salts, and by using suitable mixtures of the different colouring matters, the manufacturer is able in this manner to make a large series of very fast colour-lakes. This method is calculated to produce the same shade of lake with much greater certainty and regularity than the dyeing method.—The following proportions of ingredients have been found suitable for **Azarine**:

	dark lake	pale lake
Water	250 parts	—
Phosphate of soda, 1 : 10	—	175 parts
Soda solution, 1 : 10	70 parts	60 ,,
Turkey-red oil, 1 : 10	20 ,,	50 ,,
Stannate of soda, 1 : 10	20 ,,	20 ,,
Azarine 1 : 10	70 ,,	10 ,,
Alum solution 1 : 20	500 ,,	500 ,,

The combined solution of the first five ingredients is precipitated with a mixture of the last two in solution.

In the case of the Azarine-lakes, as with the Madder-lakes, it is most important in this method, if one wishes to obtain the most brilliant reds and pinks, to see that the materials employed, as well as the water, and the apparatus, are all free from iron, since the presence of this element has an extraordinary dulling effect upon the shade of the lakes produced. —

In addition to the above mentioned methods of precipitation and of dyeing employed in the manufacture of lakes, very important applications in this industry are derived from the fact that the Basic Colours have the property of fixing, i. e. converting into an insoluble condition, a large number of Resorcine, Acid, Azo, and Mordant Colours. With very many colouring matters of these groups the Basic Colours yield insoluble or sparingly soluble compounds, and this property is utilised for the manufacture of colour-lakes partly in accordance with the method of precipitation and partly with that of dyeing, but it is specially useful for shading purposes in connection with all lakes derived from Resorcine, Acid, Azo, and Mordant Colours.

The **dyeing** method is employed either for mere shading or for completely changing into a compound colour, the lakes which have been previously made from dye-woods. For this purpose the lakes are suspended in water, and solutions of the Basic Colours are added, and although the lakes are already in a perfectly insoluble state they still have the property of attracting the colour-bases to form complex compounds, in which the colouring matters of the dyewoods are partly combined with the colour-bases and partly with the metallic oxides by which they were originally precipitated.

The **precipitation** method is carried out by making either small or large additions of the Basic Colours when preparing lakes from Resorcine, Acid, Azo, and occasionally Mordant Colours, so that they are simultaneously precipitated with the latter; in this case they are thrown down in the form of insoluble salts, in which the colour-acids of the colouring matters, belonging to one or other of the groups mentioned, are chemically combined with the colour-bases of the Basic Colours employed.

C. The Colouring of Paper.

In the following paragraphs a brief account is given of the methods employed in the colouring of paper, for, since they are closely allied in principle with the methods of precipitation already described, it is both appropriate as well as convenient to refer to them in close connection with the methods employed in the manufacture of lakes.

The various **methods of colouring paper** may be classified as follows:

I. The Colouring of paper in the form of pulp.
II. The Colouring of paper by dipping.
III. The Colouring of paper by staining.

I. **The Colouring of Paper-pulp** is the method most frequently employed. The complete or partial utilisation of the colouring matter depends upon whether the sizing and colouring proceed simultaneously, or only unsized paper is being made. Unsized paper is coloured less frequently, for not only is it more difficult to obtain full deep shades, but they can only be produced with a considerable loss of colouring matter. For colouring paper

in the form of pulp the most suitable dyestuffs to use are the Basic Colours, because these are to a certain extent attracted and fixed by the fibrous substance of the paper itself.—The method of colouring is very simple: the paper-pulp is suspended in water (as a rule in the beating engine), and the colour solution being added, the whole is well mixed by agitation; the pulp being thus dyed, the coloured paper is obtained by running the pulp on to the sieve, &c. in the usual manner.

The colouring matters are fixed much more completely, if the sizing and colouring are done simultaneously. The sizing is usually effected by making successive additions to the paper-pulp of resin-soap and aluminium sulphate, (or in the case of the Resorcine Colours aluminium acetate).—In this manner the Basic Colours are completely precipitated throughout the paper-pulp as insoluble resinates; in the case of the Resorcine, Acid, and Azo Colours the precipitation is not quite complete.—The resin-soap is prepared by the long continued boiling of 8 oz. resin, 2 oz. soda, and $^1/_2$ gallon water until a clear solution is obtained and then making up with water to $^1/_2$ gallon.—The aluminium sulphate solution required is made by dissolving commercial aluminium sulphate in water until it stands at 15° Tw.—The aluminium acetate used with the Resorcine Colours, is obtained by dissolving 1460 parts aluminium hydrate (containing 7.5 % Al_2O_3) in 645 parts (by weight) of acetic acid 12° Tw., and diluting the solution with water until it stands at 15° Tw.—Both the colouring and the sizing are usually done in the beating-engine; to the paper-pulp suspended in water there is first added the colour solution, then the resin-soap solution, and finally the aluminium sulphate or acetate, each being added while vigorously agitating the pulp. Great care must be taken to see that the colouring matter is in a state of perfect solution, otherwise such undesirable defects as spots and points of dark colour appear ultimately in the paper. On no account must Basic Colours be dissolved along with Resorcine, Acid, and Azo Colours, because they precipitate each other and give rise to sparingly soluble compounds of a resinous nature, thus causing spots and loss of colouring matter.—Nevertheless Basic Colours are frequently associated with Resorcine, Acid, and Azo Colours, but in this case the colouring matters must be dissolved separately, and the solutions are then added to the paper-pulp successively and not simultaneously.—For 100 lbs. dry paper-pulp 5 galls. resin-soap and 5 galls. aluminium sulphate 15° Tw. are used. For sizing purposes aluminium sulphate is employed with all colouring matters except the Resorcine Colours, and with these aluminium acetate is used, because being less strongly acid it gives brighter and purer shades.—In certain exceptional cases, paper-pulp is coloured by means of Basic Colours with the addition of tannic acid and tartar-emetic, for example, when the colour must be perfectly fast to water.—Occasionally paper-pulp is also coloured by effecting the production of insoluble Azo Colours.

II. **The Colouring of Paper by Dipping** is less frequently employed. It consists essentially in passing the fully made paper through an aqueous solution of the colouring matter. The paper absorbs the colour solution and becomes dyed in consequence of the evaporation of the water during the subsequent drying process.—Very soluble colouring matters are chiefly employed for this method, for example, the Eosines, and certain Azo and Acid Colours.

III. **The Colouring of Paper by Staining** is employed in the manufacture of fancy coloured papers, and serves for the production of papers which are coloured on one side only.—The stain may **cover** the underlying paper, or it may form **a transparent glaze,** i. e. the substance of the paper appears through the stain.—In addition to the mineral colours, pigment-colours are now largely employed as covering-stains, being prepared in the form of insoluble colour-lakes. These colours are mixed with a suitable thickening, for example, dextrine, starch, &c. and then spread on the paper.—Stains for covering are also prepared by producing the lake in the staining-colour itself. The thickening is first mixed with an

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inorganic substance possessing covering power, e. g. zinc-white, white-lead, blanc-fixe, &c., a concentrated solution of the colouring matter is then added, or it is dissolved in the thickening; it is eventually precipitated in the colour-mixture itself by the addition of suitable precipitating agents, as in the manufacture of lakes, employing tannic acid for Basic Colours, lead acetate for Resorcine-Colours, and barium chloride for Acid and Azo Colours.—Transparent glaze-colours are less frequently employed. They are produced by applying coloured spirit-varnishes or coloured borax-shellac solutions.—In the preparation of the spirit-varnishes the purest and most concentrated colouring matters readily soluble in alcohol are employed; specially suitable are the following: Auramine conc., Phosphine extra and superfine, Vesuvine conc., Safranine A N extra, New Magenta, Magenta, Methyl Violet chem. pure, Light Blue superfine sol. in spirit, Malachite and Brilliant Green cryst. extra, New Green O, Eosine B A cryst., Eosine extra sol. in spirit, Cyanosine sol. in spirit, Rosazeïn extra, Victoria Yellow conc.

The colouring matters are dissolved in a well made varnish, prepared from the following materials

12 1/2 oz. Gum Sandarac
20 oz. Alcohol
2 oz. Camphor
3 1/2 oz. Venetian turpentine.

This mixture is allowed to digest for several days at a gentle heat and then filtered; 1 to 2 parts colouring matter are dissolved in 100 parts of the varnish on the water-bath, and the solution thus obtained is used as the stain.—These spirit-varnishes are, however, not only used for paper-staining but also very largely for colouring objects of metal, wood, cellulose, and glass, as well as bronze-powders.

The borax-shellac solution is made by heating together the following ingredients on the water-bath,

7 1/2 oz. Shellac
2 1/2 oz. Borax
50 oz. Water.

In this solution there is dissolved 1 to 3 oz., according to the shade required, of such colouring matters as are readily soluble and fast to alkali, e. g. Scarlet (various marks), Amaranth, Victoria Yellow, Orange G, Scarlet 6 R, Fast Blue and Patent Blue (various marks), Acid Violet N, also various marks of Eosine, Phloxine, and Rose Bengale. The coloured solutions thus obtained are allowed to cool and are then ready for use.

REACTIONS OF THE COLOURING MATTERS

IN

POWDER FORM.

The Method of trying the Reactions.

In the following pages a record is given in tabular form of the reactions of a number of colouring matters, the tests having been made with the pure products. These reactions may serve not only for the identification of the products referred to, but also for gaining some insight as to the composition of new and unknown colouring matters. In many cases, by selecting suitable reactions, it may be possible to separate the constituents of a mixture, and to isolate them in such a manner that each can be identified with certainty; for investigations of this kind however it is impossible to give rules which are generally applicable, and much practice and manipulative skill is required in order to obtain accurate results rapidly.

If the colouring matter to be examined is in the solid or powder form, it is dissolved in 1000 times its weight of water; in the case of paste-colours a larger quantity is taken, according to the per centage of dry substance they contain. If the colouring matter is soluble, either entirely or nearly so, the solution is filtered, so that in the event of turbidity or precipitation occurring during the examination, there need be no doubt upon the point. If however the colouring matter is sparingly soluble or altogether insoluble, the tests are made with a mixture of the finely divided colouring matter held in suspension in water (1 : 1000), e. g. as with the alizarins. Only when tests are made to determine the solubility of the colouring matter in alcohol, ether, and benzene, or to study its behaviour with concentrated sulphuric acid, is it necessary to use it in the dried condition, i. e. undiluted.

When making these solubility tests, about 0,1 gram of the colouring matter is added to 20 c. c. of the necessary reagent, the mixture is then well shaken, boiled, and filtered. When concentrated sulphuric acid is used, it is also desirable not to take too much colouring matter, so that the colour of the solution may not be too dark; a portion of the solution is then poured into a test-tube containing cold water, and the effect is noted, for example, whether precipitation ensues, what colouration is produced, etc; eventually the solution is filtered.

The rest of the acid solution is gradually heated to the boiling point, and a note is taken of any change of colour which may occur, the liquid is then allowed to cool and diluted by pouring into cold water.

With respect to the reactions with other acids, also with alkalis and salts, equal amounts of colour solution and the reagent are mixed together in a test-tube; one half of the mixture is allowed to stand in the cold, and if precipitation takes place, it is filtered; the remainder is heated to the boiling point, note being taken of any changes which occur, and it is then filtered.

For reducing with zinc powder in conjunction with acids or alkalis, 20 c. c. of the colour solution are mixed with about 5 grams zinc powder, then about 20 c. c. acid or alkali are added, and the whole is well shaken, then boiled till decolourised and at once filtered, after which one must observe whether or not the filtrate becomes coloured on exposure to the air.

The reagents employed are as follows:

Water:	distilled.
Alcohol:	absolute.
Ether:	chemically pure.
Benzene:	,, ,,
Sulphuric acid. conc.:	,, ,,
,, ,, dil.:	100 grams conc. acid per litre water.
Hydrochloric acid, dil.:	normal, (100 c. c. chem. pure acid (Sp.-G. 1,16) diluted to 1 litre.
Nitric acid:	chem. pure nitric acid diluted to normal strength.
Sodium hydrate:	normal, (100 c. c. sodium hydrate solution (Sp.-G. 1,3) diluted to 1 litre.
Ammonia:	commercial ammonia (Sp.-G. 0,9—0,1).
Sodium carbonate:	100 gr. Solvay soda per litre.
,, acetate:	100 gr. cryst. salt per litre.
Magnesium acetate:	100 gr. ,, ,, ,, ,,
Calcium ,,	100 gr. ,, ,, ,, ,,
Barium ,,	100 gr. ,, ,, ,, ,,
Lead ,,	100 gr. ,, ,, ,, ,,
Tannin solution:	100 gr. tannic acid per 500 c. c. water, dissolved and mixed with solution of 100 grams sodium acetate per 500 c. c. water.
Alum:	50 gr. cryst. salt per litre.
Potassium bichromate:	50 gr. ,, ,, ,, ,,
Ferric chloride:	100 gr. ,, ,, ,, ,,
Mercuric chloride:	50 gr. ,, ,, ,, ,,
Stannous chloride:	100 gr. ,, ,, ,, ,,
Calcium hypochlorite:	$1^{1}/_{2}{}^{0}$ Tw., freshly prepared (Sp.-G. 1,0075)
Acetic acid:	12^{0} Tw. (Sp.-G. 1,06).

	Auramine conc.	Phosphine	Chrysoïdine
Colour	Yellow powder.	Red-orange powder.	Large, black crystals, with metallic lustre.
Solubility in Water	Very soluble.	Very soluble, orange with yellow fluorescence.	Very soluble.
Solubility in Alcohol	Very soluble, yellow.	Very soluble, orange.	Very soluble.
Solubility in Ether	Insoluble.	Soluble only in minute traces; filtrate pale yellow.	Soluble in traces, pale yellow.
Solubility in Benzene	Insoluble.	Insoluble.	Soluble in very minute traces only.
Heated on platinum foil	The powder becomes red-orange; yellow vapour is given off; it then burns with a large flame and a black residue remains which burns away and leaves scarcely any ash behind.	Much yellow vapour is given off; then it ignites; the remaining dark grey carbon burns away with great difficulty and leaves no ash behind.	Melts, gives off a brown vapour having an aromatic odour, and then burns with a large flame. A black residue remains, which burns away and leaves no ash behind.
Concentrated sulphuric acid	Dissolves with effervescence and evolution of hydrochloric acid, solution colourless; on dilution with water becomes yellow; conc. solution on heating becomes a pale brown-yellow.	Dissolves with effervescence and evolution of hydrochloric acid, solution yellow with green fluorescence; on dilution with water becomes orange with yellow fluorescence; conc. solution on heating becomes dark olive-yellow.	Dissolves with evolution of hydrochloric acid, solution yellow, becoming red at the edge of the basin; on dilution with water becomes orange; conc. solution on heating becomes dark olive.
Dilute sulphuric or hydrochloric acid	Unchanged; decolourised on boiling.	Unchanged.	Unchanged.
Dilute nitric acid	On boiling, a pale yellow solution.	Unchanged.	Almost unchanged.
Sodium hydrate	White precipitate giving milky turbid filtrate; extracted on shaking with ether, becoming colourless.	Quantitative yellow precipitate; extracted with ether, yellow solution with green fluorescence.	Orange yellow precipitate; extracted with ether.
Ammonia	Same as with sodium hydrate.	Same as with sodium hydrate.	Partial orange-yellow precipitate, soluble in excess, extracted with ether, yellow solution.
Sodium carbonate	Yellow milky precipitation, almost quantitative.	Quantitative yellow precipitate.	Partial orange-yellow precipitate, dissolves on heating.
Tannin reagent	Largely precipitated yellow; on boiling the precipitate becomes brown, resinous, and partially soluble.	Almost quantitative orange-yellow precipitate; on boiling becomes resinous and partially soluble.	Partial orange-brown precipitate; soluble on heating.
Alum	Unchanged.	Unchanged.	Unchanged.
Potassium bichromate	Quantitative yellow precipitate; on heating becomes resinous, and for the most part dissolves.	Quantitative orange precipitate; on heating becomes resinous, and for the most part dissolves.	Quantitative brick-red precipitate, on heating becomes dark brown, resinous.
Ferric chloride	In the cold unchanged; on heating turbid brown-yellow.	In the cold unchanged; on heating turbid brown-yellow.	In the cold unchanged; on heating turbid brown-yellow.
Mercuric chloride	Yellow precipitate, giving turbid filtrate; on heating clear solution.	Orange precipitate, giving turbid filtrate; on heating dissolves.	Partial orange precipitate giving turbid filtrate; on heating dissolves.
Stannous chloride	Unchanged.	Unchanged.	No precipitate; on heating rapidly decolourised.
Calcium hypochlorite	Quantitative pale dirty yellow precipitate; on standing becomes a dirty red colour.	Quantitative yellow precipitate.	Almost quantitative orange-yellow precipitate, filtrate pale yellow.
Zinc powder and ammoniacal solution	Filtrate colourless; colour does not reappear; on standing the precipitate on filter becomes yellowish.	Quickly reduced; filtrate becomes pale yellow; edge of the filter-paper yellow.	Rapidly decolourised; filtrate and edge of the filter-paper yellowish.
Zinc powder and acetic acid solution	Becomes blue on reduction.	Colour redeveloped in filtrate, (reduced with great difficulty). Edge of filter-paper coloured yellow.	Rapidly decolourised; filtrate almost colourless.

	Vesuvine	Rosazeïne	Magenta
Colour	Dark brown powder.	Dull violet-red powder.	Dark green crystals, with metallic lustre.
Solubility in Water	Somewhat readily soluble.	Readily soluble, ruby-red solution with orange fluorescence.	Readily soluble.
Solubility in Alcohol	Readily soluble.	Readily soluble, carmine-red solution with orange fluorescence.	Readily soluble.
Solubility in Ether	Insoluble.	Slightly soluble, solution with orange fluorescence.	Soluble in minute traces; crystals become blue-violet.
Solubility in Benzene	Insoluble.	Almost insoluble.	Insoluble; crystals become blue.
Heated on platinum foil	Gives off white vapour and puffs up to a grey mass, which burns away with some difficulty and leaves little ash.	Melts to a violet-liquid with evolution of white vapour, then burns with a large flame, and leaves no ash.	Gives off slight red vapour; then melts and burns with a highly luminous and smoky flame, leaving a black carbon which slowly burns away leaving no ash.
Concentrated sulphuric acid	Dissolves with effervescence and evolution of hydrochloric acid, solution dark brown, at the edge of the basin bluish-red; diluted with water gives dark yellow-brown solution with partial stringy precipitation; conc. solution on heating becomes black-olive.	Dissolves giving yellow solution, at the edge of the basin red; diluted with water gives red solution; conc. solution becomes dark brown on heating.	Dissolves with effervescence and evolution of hydrochloric acid, solution dark brown-yellow; diluted with water becomes yellowish red, then yellow, and finally almost colourless; conc. solution on heating becomes dark olive-brown.
Dilute sulphuric or hydrochloric acid	In the cold partial stringy dark brown precipitation; on heating dissolves giving dark reddish-yellow solution.	On heating fluorescence disappears; is not extracted by ether.	Solution first yellowish-red, then yellow, and finally almost colourless; on heating the ruby-red colour returns.
Dilute nitric acid	Same as with dilute sulphuric or hydrochloric acid.	Same as with dilute sulphuric or hydrochloric acid; colour of solution becomes paler only with very long boiling.	Same as with dilute sulphuric or hydrochloric acid.
Sodium hydrate	Partial yellow-brown precipitate; extracted with ether.	Unchanged; on addition of ether the aqueous solution becomes pale pink, the ether colourless.	Quantitative red-brown precipitate both in the cold and on heating; extracted with ether red solution, the conc. ethereal solution is yellow, when diluted rose-red.
Ammonia	Partial pale yellow-brown precipitate; extracted with ether yellow solution.	Same as with sodium hydrate.	With excess colourless solution; a slight addition causes turbidity.
Sodium carbonate	Partial yellow-brown precipitate, dissolves on heating.	In the cold unchanged, on heating the fluorescence disappears.	In the cold partial resinous precipitate; on heating colour of solution becomes paler, precipitate dirty red-violet, filtrate pale pink.
Tannin reagent	Partial red-brown precipitate; dissolves on heating.	Partial precipitation both in the cold and also when heated.	In the cold almost quantitative precipitate; on heating it becomes resinous, and partially dissolves.
Alum	Partial brown precipitate; dissolves on heating.	Unchanged.	In the cold partial red precipitate; dissolves on heating.
Potassium bichromate	Quantitative dark orange-brown precipitate; on heating becomes black and powdery.	In the cold partial dirty red precipitate; dissolves on heating.	Quantitative red-brown precipitate; on heating partially dissolves, resinous; the washed precipitate is soluble in water.
Ferric chloride	In the cold unchanged, on heating becomes yellow-brown and turbid.	Unchanged.	In the cold unchanged; on heating becomes yellow-brown and turbid, gives turbid filtrate.
Mercuric chloride	Almost quantitative brown precipitate, on heating partially dissolves.	Violet-red precipitation, filtrate turbid, dichroïc, with reflected light red, with transmitted light violet.	In the cold brownish turbidity; on heating clear solution.
Stannous chloride	Partial orange-brown precipitate; on heating rapidly decolourised.	In the cold almost quantitative violet-red precipitate; on heating for the most part dissolves.	In the cold partial slight precipitate; on heating dissolves with separation of basic stannous chloride (white precipitate).
Calcium hypochlorite	Almost quantitative yellow-brown precipitate, filtrate pale yellowish.	In the cold turbid, pink; on heating, colourless solution with a few red flocks.	Brown precipitate; filtrate yellowish.
Zinc powder and ammoniacal solution	Rapidly decolourised; filtrate and edge of filter-paper slightly orange.	Quickly reduced; the filtrate gradually becomes pink with orange fluorescence; edge of filter-paper pink.	Filtrate colourless; edge of filter-paper red.
Zinc powder and acetic acid solution	Rapidly decolourised; filtrate a dirty reddish colour.	Somewhat quickly reduced; the filtrate gradually becomes pink with orange fluorescence; edge of filter-paper pink.	Reduced with some difficulty; filtrate colourless, on boiling pale pink.

		Para-Magenta	New-Magenta	Azine Scarlet G conc.
Colour		Dark green crystals, with metallic lustre.	Green powder, with metallic lustre.	Brown powder.
Solubility in	Water	Readily soluble; purple-red.	Magenta-red solution.	In cold water not very readily soluble; in boiling water readily soluble.
	Alcohol	Readily soluble.	Magenta-red solution.	Readily soluble; the solution exhibits a strong fluorescence.
	Ether	Insoluble; the crystals become blue.	Soluble in traces with pink colour.	Insoluble.
	Benzene	Insoluble; the crystals become blue.	Insoluble.	Insoluble.
Heated on platinum foil		Melts and burns; a black porous mass remains, which on further heating burns away and leaves no ash.	Carbonises without giving off much smoke and leaves little ash.	Cokes together with emission of yellow-brown vapours.
Concentrated sulphuric acid		Dissolves with effervescence and evolution of hydrochloric acid, solution yellow; diluted with water, becomes red, then yellow, pale yellow, and finally almost colourless; on heating the conc. solution becomes dark yellow-brown.	Orange-yellow solution; diluted yellow, heated black brown-olive, diluted dirty olive-brown, on standing red-brown flocculent precipitate.	Blue-green solution; on dilution partial precipitation giving red-brown precipitate.
Dilute sulphuric or hydrochloric acid		The solution becomes orange-red, yellow, finally colourless; on heating the colour again becomes ruby-red.	Cold, solution yellow-brown; hot, ruby-red.	In the cold red turbidity; on boiling the original colour is restored.
Dilute nitric acid		Same as with dilute sulphuric or hydrochloric acid.	Cold, solution yellow-brown; hot, ruby-red.	In the cold yellow-brown turbidity, disappears on boiling.
Sodium hydrate		Cold or hot, quantitative red-brown precipitate; extracted with ether red solution; conc. ethereal solution is yellow, dilute rose-red.	Cold, complete precipitation, red; hot, yellow-brown precipitate, filtrate colourless.	Unchanged.
Ammonia		Colourless solution.	Solution pale yellowish-red.	Unchanged.
Sodium carbonate		In the cold, partial red precipitate; on heating precipitate bright pink, filtrate colourless.	Cold, partial magenta-red precipitation; filtrate pink. Hot, slight dirty red precipitation. Filtrate almost colourless.	Unchanged.
Sodium acetate		—	—	Unchanged.
Magnesium acetate		—	—	Unchanged.
Calcium acetate		—	—	Unchanged.
Barium acetate		—	—	Unchanged.
Lead acetate		—	—	Unchanged.
Tannin reagent		In the cold, almost quantitative precipitation; on heating, precipitate becomes resinous, and partially dissolves.	Completely precipitated, brown-red.	Scarlet-red precipitate, dissolves on boiling.
Alum		In the cold, partial red precipitate; dissolves on heating.	Cold, slight brown-red turbidity; hot, clear magenta-red solution.	Unchanged.
Potassium bichromate		Quantitative red-brown precipitate; on heating, partly dissolves, resinous.	Cold, completely precipitated brown-red; hot, almost clear orange-red.	Brown precipitate, insoluble on boiling.
Ferric chloride		In the cold, slight precipitation; on heating, brown-red solution.	Cold, dirty claret-red precipitate; hot, brown precipitate.	—
Mercuric chloride		In the cold, brownish turbidity; on heating, clear solution.	Cold, partial magenta-red precipitation; hot, clear red solution.	—
Stannous chloride		Partial precipitation, dissolves on heating.	Cold, partial violet-red precipitation, filtrate pink; hot, almost entirely soluble, red.	Complete dirty red precipitation; filtrate not coloured.
Bleaching powder		Brown precipitate; filtrate yellowish.	Cold, complete red-brown precipitation; hot, powdery red-brown precipitate.	Cold, dark coloured or black precipitate; on heating dissolves to form a bright yellow solution.
Zinc powder and ammoniacal solution		The filtrate is colourless, edges of the filter red.	Rapidly decolourised on boiling; filtrate colourless, with acetic acid dark pink.	Solution rapidly decolourised; on exposure to air the colour is more or less restored.
Zinc powder and sodium hydrate		—	—	Solution rapidly decolourised; on exposure to air the colour is more or less restored.
Zinc powder and acetic acid solution		Reduced with some difficulty; the filtrate is colourless, on boiling becomes pale pink.	Easily reduced; filtrate colourless.	Solution quickly reduced; on exposure to air the colour is more or less restored.

	Safranine concentrated	Rosolane cryst.	Methylene Violet 3RA
Colour	Brown powder.	Crystalline, olive-green powder.	Brown powder.
Solubility in Water	Readily soluble.	Somewhat readily soluble; red-violet.	Soluble with a wine-red colour.
Solubility in Alcohol	Readily soluble, red with yellow fluorescence.	Somewhat readily soluble; beautiful red-violet.	Soluble with a wine-red colour.
Solubility in Ether	Insoluble; filtrate pale yellowish.	Soluble in slight traces.	Soluble in traces.
Solubility in Benzene	Insoluble.	Insoluble.	Insoluble.
Heated on platinum foil	A reddish vapour is given off; the mass melts, ignites, swells up a little to form a black mass, which burns away and leaves but little ash behind.	Melts and swells up to a black, lustrous mass, which burns away leaving an unfused ash which appears yellow when hot, white when cold.	Puffs up very strongly, emitting violet vapours.
Concentrated sulphuric acid	Dissolves with effervescence and evolution of hydrochloric acid gas, solution green, at the edges blue; diluted with water becomes blue, violet, and finally red; slight vermilion precipitate; the conc. solution on heating becomes blackish-olive.	Dissolves with evolution of hydrochloric acid gas, solution black-green, at the edges blue; diluted with water becomes blue, then violet (solution). The conc. solution on heating becomes dark blue, then blackish.	Green solution, on dilution becomes first blue, then violet, and finally wine-red.
Dilute sulphuric or hydrochloric acid	Partial dirty orange-red precipitate; dissolves on heating.	Partial flocculent precipitate, with sulphuric violet, with hydrochloric violet-blue; dissolves on heating.	Somewhat darker and bluer on heating.
Dilute nitric acid	Partial red-brown precipitate; extracted with ether giving red solution.	As with dilute sulphuric acid.	Somewhat darker and bluer on heating.
Sodium hydrate	Partial red-brown precipitate; extracted with ether giving red solution.	Quantitative, blue-black precipitate; extracted with ether giving violet solution.	In the cold, little change; on heating, becomes turbid through separation of colour-base.
Ammonia	Remains in solution, extracted with ether giving red solution.	Quantitative violet precipitate; extracted with ether giving violet solution.	Unchanged.
Sodium carbonate	Partial precipitation.	Quantitative violet-black precipitate.	Unchanged.
Sodium acetate	—	—	Unchanged.
Magnesium acetate	—	—	Unchanged.
Calcium acetate	—	—	Unchanged.
Barium acetate	—	—	Unchanged.
Lead acetate	—	—	Unchanged.
Tannin reagent	Partial precipitation, on heating somewhat more soluble.	Quantitative violet precipitate; little soluble on heating.	Partial red-violet precipitate.
Alum	Unchanged.	Partial violet precipitate, more soluble on heating.	Unchanged.
Potassium bichromate	Quantitative red precipitate, more soluble on heating.	Quantitative dark brown precipitate, on heating somewhat more soluble.	Brown precipitate, which dissolves again on boiling.
Ferric chloride	Partial vermilion-red precipitate; soluble on heating.	Almost quantitative dark violet-blue precipitate; on heating turbid red.	—
Mercuric chloride	Quantitative light red-brown precipitate; dissolves on heating.	Mostly precipitated, violet; dissolves on heating, red-violet.	—
Stannous chloride	Partial, buff coloured precipitate; dissolves on heating.	Quantitative red-violet precipitate; dissolved for the most part on heating.	Extremely fine red-violet precipitate.
Calcium hypochlorite	Quantitative, dirty violet precipitate; on standing becomes blackish-brown.	Quantitative, violet-black precipitate; on standing becomes paler and of a dirty colour.	In the cold black-brown precipitate, dissolves on heating. The colouring matter is very soon completely destroyed.
Zinc powder and ammoniacal solution	Easily reduced; the colour is restored immediately.	Filtrate a pale bright violet.	Colour incompletely destroyed.
Zinc powder and sodium hydrate	—	—	Colour incompletely destroyed.
Zinc powder and acetic acid solution	Easily reduced; the colour is restored immediately.	Easily reduced; the orange-yellow filtrate at once becomes red-violet, also the edges of the filter-paper.	Reduced to a bright yellow solution. Colour partially restored on exposure to the air.

		Methylene Violet RRA	Methylene Violet BN	Methyl Violet 2B superfine
Colour		Dark violet-brown powder.	Dark brown powder.	Olive-green crystalline powder.
Solubility in	Water	Readily soluble.	Sparingly soluble, violet-red solution.	Readily soluble, violet.
	Alcohol	Readily soluble.	Violet-red solution.	Readily soluble, violet.
	Ether	Soluble in slight traces.	Soluble in traces, pink.	Soluble in traces.
	Benzene	Soluble in slight traces.	Soluble in traces, pink.	In the cold not very soluble, on heating moderately soluble.
Heated on platinum foil		Swells up to a grey mass, which burns away leaving a white unfused ash which preserves the form of the swollen mass.	Melts, swells up considerably and evolves much brown vapour, ignites, leaves a good deal of reddish ash.	Emits some white vapours; the mass melts, ignites and burns with a luminous flame leaving black carbon, which burns away very slowly leaving no ash.
Concentrated sulphuric acid		Dissolves with effervescence and evolution of hydrochloric acid gas, solution green, diluted with water becomes blue then red-violet; on heating, the conc. solution becomes dark green.	Green solution. Diluted becomes blue then blue-violet. On heating brown, on dilution yellow.	Dissolves with evolution of hydrochloric acid gas, solution orange; diluted with water: orange-brown, brown-olive, olive, green, blue-green; on heating, the conc. solution becomes olive-brown, then brown.
Dilute sulphuric or hydrochloric acid		Unchanged.	Violet solution.	Deep red-brown solution, in thin layers olive-green; on standing, green (paler).
Dilute nitric acid		Unchanged.	In the cold a violet solution; hot, violet-red.	Same as with dilute sulphuric or hydrochloric acid.
Sodium hydrate		Not precipitated; extracted with ether, red solution; the aqueous solution bluish-red, gradually colourless.	Cherry-red solution.	Quantitative violet-brown precipitate; extracted with ether, violet solution, if concentrated deep orange.
Ammonia		Same as with sodium hydrate.	Violet-red solution.	Becomes continually paler, more turbid, and redder, quantitative dirty pale greyish-red precipitate; extracted with ether, orange solution; the ethereal extract diluted with ether, lilac.
Sodium carbonate		Unchanged.	Cherry-red solution.	In the cold, unchanged; on heating, pale dirty red, turbid.
Tannin reagent		Mostly precipitated red-violet; on heating somewhat soluble.	In the cold, violet precipitate, filtrate pink; hot nearly clear ruby-red solution.	Quantitative violet precipitate: on heating, filtrate becomes slightly red.
Alum		Unchanged.	Unchanged.	Unchanged.
Potassium bichromate		Partial red-brown precipitate; dissolves on heating.	In the cold completely precipitated brown-black; hot, partially soluble, red.	Quantitative black-violet precipitate; mostly soluble on heating, partly resinous.
Ferric chloride		In the cold unchanged; on heating, turbid, red; gives turbid filtrate.	In the cold unchanged; on heating, turbid, red, passes through the filter.	Turbid blue, on heating olive, on boiling turbid yellow-brown.
Mercuric chloride		In the cold turbid violet with brick-red fluorescence; on heating violet-red solution.	In the cold partial violet precipitation, filtrate turbid blue with red fluorescence. On heating clear cherry-red solution.	Turbid (partially salted out).
Stannous chloride		Unchanged.	Partial violet precipitation, filtrate pink. On heating precipitate almost entirely soluble cherry-red.	Almost quantitative violet precipitate; on heating indigo-blue partly soluble; filtrate azure-blue, with green fluorescence.
Calcium hypochlorite		Quantitative black-violet precipitate; filtrate yellowish.	On standing reddish-grey turbidity, filtrate yellow. On heating clear, colourless.	Turbid violet, then paler.
Zinc powder and ammoniacal solution		Quickly reduced; the colour is immediately restored.	Easily reduced, filtrate colourless, becomes at once cherry-red.	Filtrate colourless.
Zinc powder and acetic acid solution		Somewhat quickly reduced; the colour is restored immediately.	Easily reduced, filtrate orange-yellow, becomes at once red.	Reduced with some difficulty; filtrate colourless, the violet colour being very slowly restored.

		Violet crystals	Blue for Printing R	Blue for Printing B
Colour		Yellow-green crystals, with metallic lustre.	Dark brown-violet powder.	Dark brown-violet powder.
Solubility in	Water	Readily soluble.	Sparingly soluble, violet.	Sparingly soluble, violet.
	Alcohol	Readily soluble.	Dark blue-violet solution.	Dark blue-violet solution.
	Ether	Almost insoluble; filtrate pale lilac.	Somewhat soluble, violet.	Somewhat soluble, purplish-red.
	Benzene	Somewhat soluble; the crystals become blue.	Somewhat soluble, violet.	Somewhat soluble, bluish-pink.
Heated on platinum foil		The crystals melt and burn with a very smoky flame, leaving behind a black carbon, which burns away leaving no ash.	Melts, swells up considerably, emits much vapour, giving a carbon which burns away and leaves a good deal of ash containing iron.	Melts, swells up considerably, emits much vapour, giving a carbon which burns away leaving a good deal of ash containing iron.
Concentrated sulphuric acid		Dissolves with effervescence and evolution of hydrochloric acid gas, solution orange-yellow; diluted with water olive green, yellow-green, yellow; on heating, the conc. solution becomes dark brown.	Blue-violet solution. Diluted partial blue-violet precipitation, filtrate red-violet. On heating blue-black, diluted slight bluish-grey precipitate, filtrate blue.	Blue-violet solution, diluted partial blue-violet precipitation, filtrate red-violet. On heating blue-black, diluted slight bluish-grey precipitate, filtrate blue.
Dilute sulphuric or hydrochloric acid		With sulphuric acid: olive-green, on heating emerald-green, on standing yellow-green; with hydrochloric acid: light brown-yellow, on heating slightly more greenish.	Partial violet precipitation, on heating more soluble.	Partial violet precipitation, on heating more soluble.
Dilute nitric acid		In the cold, olive-green; on heating, more brown, then red; on boiling becomes turbid, brown-red with greenish-blue appearance; filtrate green; on the filter a red-brown-powder.	In the cold, partial violet precipitation; on heating, almost entirely soluble.	In the cold, partial violet precipitation; on heating, almost entirely soluble.
Sodium hydrate		Blue-violet, quantitative precipitate; extracted by ether, pale yellow solution.	In the cold, completely precipitated dirty brown-red; on heating, some what soluble with a pink colour.	In the cold, completely precipitated brown-red; on heating, somewhat soluble with a pink colour.
Ammonia		The solution becomes milky, eventually milk-white, filtering turbid; extracted with ether colourless solution.	In the cold, almost completely precipitated dirty brown-red; on heating, somewhat soluble with a pink colour.	In the cold, almost completely precipitated violet-red; on heating, somewhat soluble with a pink colour.
Sodium carbonate		In the cold, remains in solution; on heating, becomes turbid and paler, eventually milk-white, filtering turbid.	In the cold, almost completely precipitated dirty brown-red; on heating, becomes soluble in traces with a pink colour.	In the cold, almost completely precipitated violet-red; on heating, some what soluble with a pink colour.
Tannin reagent		In the cold and on heating, quantitative precipitate.	Completely precipitated blue-violet.	Completely precipitated blue-violet.
Alum		Unchanged.	Partial violet precipitation, filtrate violet-red, on heating darker.	Partial violet precipitation, filtrate violet-red, on heating darker.
Potassium bichromate		Quantitative violet-black precipitate with metallic lustre; on heating partly soluble (resinous).	Brown-violet precipitation, filtrate on heating somewhat darker, redder.	Brown-violet precipitation, filtrate on heating somewhat darker, redder.
Ferric chloride		In the cold, blue solution; on heating, turbid brown-yellow, filters turbid.	In the cold, brown-violet; on heating, brown turbidity, filtrate turbid.	In the cold, brown-violet; on heating, brown turbidity, filtrate turbid.
Mercuric chloride		In the cold, unchanged; on heating, very turbid, green iridescence, resinous precipitate, filtrate lilac.	In the cold, almost completely precipitated violet; on heating, somewhat soluble.	In the cold, partial violet precipitation; on heating, more soluble.
Stannous chloride		In the cold, quantitative violet precipitate; on heating, partly soluble (blue).	In the cold, almost completely precipitated blue-violet; on heating, partly soluble.	In the cold almost completely precipitated blue-violet, on heating partly soluble.
Calcium hypochlorite		Turbid milky, pale blue, then white; precipitate white; filtrate colourless.	On standing, colourless solution with slight brown turbidity; on heating, clear.	On standing, colourless solution with slight brown-turbidity; on heating, clear.
Zinc powder and ammoniacal solution		Filtrate colourless; edges of the filter-paper lilac.	Easily reduced colourless; filtrate quickly becomes pink.	Easily reduced colourless, filtrate quickly becomes pink.
Zinc powder and acetic acid solution		Reduced with difficulty; filtrate becomes pale blue; edges of the filter-paper pale blue-violet.	Easily reduced, yellow solution; filtrate immediately becomes pink, then brownish-red.	Easily reduced, yellow solution; filtrate immediately becomes pink, then brownish-red.

	Blue for Printing BB	Induline for Printing R	Indamine Blue R paste
Colour	Dark brown-violet powder.	Brown-black powder.	Black paste.
Solubility in Water	Sparingly soluble, blue.	Sparingly soluble, violet.	Blue-violet solution (sparingly soluble).
Solubility in Alcohol	Dark blue solution.	Dark violet solution.	Reddish-blue solution.
Solubility in Ether	Somewhat soluble, purplish-red.	Red solution.	Insoluble.
Solubility in Benzene	Somewhat soluble, yellowish-pink.	Red solution.	Insoluble.
Heated on platinum foil	Melts, swells up strongly and emits much vapour, giving a carbon which burns away and leaves a good deal of ash containing iron.	Melts, swells up. Emits violet coloured vapours, giving a carbon which leaves but little ash.	When dried appears as a red-brown mass, which on further heating swells up, emits vapour, giving a carbon which leaves a good deal of greyish-white ash.
Concentrated sulphuric acid	Blue-violet solution. Diluted partial blue-violet precipitation, filtrate violet. On heating blue-black, diluted slight bluish-grey precipitate, filtrate blue.	Blue-violet solution, diluted violet, on standing partial violet precipitation; on heating dark blue-grey, on diluting blue-green.	Dissolves with effervescence, dark blue-violet solution, diluted azure-blue, on standing a short time flocculent turbidity, on heating greenish-blue, diluted reddish-blue, on standing a slight flocculent turbidity.
Dilute sulphuric or hydrochloric acid	Partial blue precipitation, on heating more soluble.	Unchanged.	Unchanged.
Dilute nitric acid	In the cold, slight blue precipitate; on heating, almost entirely soluble.	In the cold, unchanged; on heating, brown-red.	In the cold, slight grey-violet precipitate, which dissolves on boiling, otherwise unchanged.
Sodium hydrate	Partial violet precipitation. Filtrate in the cold, blue; on heating, pale violet.	In the cold, completely precipitated red; on boiling, somewhat soluble, filtrate pink.	In the cold, completely precipitated dark violet; on heating, somewhat soluble (red-violet).
Ammonia	In the cold, almost completely precipitated blue; on heating, partially soluble.	In the cold, almost completely precipitated red; on heating, somewhat soluble, filtrate pink.	Same as with sodium hydrate.
Sodium carbonate	In the cold, partial precipitation blue; on heating, more soluble.	In the cold, almost completely precipitated dirty red; on heating, somewhat soluble. Filtrate pink.	Same as with sodium hydrate.
Tannin reagent	Almost completely precipitated, blue.	Completely precipitated, violet.	Completely precipitated, blue-black.
Alum	Partial precipitation, blue; on heating more soluble.	In the cold, partial precipitation, violet; on heating, clear violet solution.	Unchanged.
Potassium bichromate	Black-green precipitate; on heating, filtrate olive.	In the cold, completely precipitated brown-violet, the precipitate almost entirely soluble on boiling.	Completely precipitated black.
Ferric chloride	In the cold, blue turbidity; on heating, greenish turbidity, filtrate turbid.	In the cold, violet precipitation; on heating, clear solution.	On boiling, slight precipitation, dirty brown.
Mercuric chloride	In the cold, partial precipitation blue; on heating, more soluble.	In the cold, partial violet precipitation, filtrate violet; on heating, clear red-violet solution.	In the cold, completely precipitated dark-blue; on boiling, almost clear violet solution.
Stannous chloride	Slight blue-violet turbidity, filtrate pink.	In the cold, almost completely precipitated violet, filtrate pink; on heating, partly soluble, filtrate violet.	In the cold partial grey-violet precipitation, on heating more soluble.
Calcium hypochlorite	On standing, colourless solution with slight blue-green turbidity; on heating, clear.	Becomes immediately paler, a brown-yellow; on heating, quickly decolourised.	In the cold, completely precipitated red-brown, precipitate becomes powdery on boiling.
Zinc powder and ammoniacal solution	Easily reduced, colourless; filtrate rapidly becomes blue.	Decolourised, filtrate at once becomes pink, with acetic acid violet red.	Easily reduced, filtrate at once becomes red-violet, with acetic acid bluer.
Zinc powder and acetic acid solution	Easily reduced, colourless; filtrate at once becomes pale blue.	Reduced yellow, filtrate remains yellow-brown.	After reduction yellow, filtrate yellow-brown.

	Direct Blue	Indamine Blue N	Direct Blue N
Colour	Blue-black paste.	Grey powder.	Dark reddish-blue powder.
Solubility in Water	Sparingly soluble, blue.	Sparingly soluble, dirty blue-violet.	Violet solution.
Solubility in Alcohol	Blue solution.	Dark reddish-blue solution.	Blue-violet solution.
Solubility in Ether	A trace of reddish tint.	Insoluble.	Insoluble.
Solubility in Benzene	Soluble in traces, pink.	Insoluble.	Insoluble.
Heated on platinum foil	When dried the mass swells up, emits brown vapours, giving a carbon which leaves an ash containing iron.	Melts, swells up, emits vapour giving a carbon which leaves a little white ash.	Sinters together, swells up, emits vapour, giving a carbon which leaves a good deal of brownish ash.
Concentrated sulphuric acid	Blue-violet solution, diluted blue-violet, on standing partial precipitation blue; on heating dark blue-grey, diluted violet, on standing brown flocks separate.	Dark green solution, diluted reddish-blue; on heating dark olive-brown, diluted brown, on standing almost complete dark precipitation, filtrate pink.	Dark green solution, diluted violet; on heating blackish, diluted violet turbidity, ruby-red filtrate.
Dilute sulphuric or hydrochloric acid	Unchanged.	Slight violet turbidity, filtrate on heating somewhat redder violet.	Somewhat redder violet.
Dilute nitric acid	In the cold, partial precipitation dark blue; on boiling, mostly soluble.	Partial precipitation dirty grey-violet, violet-red filtrate.	In the cold, a little redder; on heating, a slight grey turbidity, filtrate violet-red.
Sodium hydrate	In the cold, complete precipitation violet-black; on heating somewhat soluble, filtrate violet.	In the cold, completely precipitated dirty grey-violet; on heating, a trace is soluble.	Dark blue-violet precipitate, filtrate in the cold pink; on heating, more soluble, filtrate violet-red.
Ammonia	In the cold, complete precipitation blue-black; on heating, somewhat soluble, filtrate pale blue.	In the cold, complete precipitation dirty grey-violet; on heating, somewhat soluble violet.	Dark blue-violet precipitate, filtrate violet.
Sodium carbonate	In the cold, almost complete precipitation violet-black, filtrate bluish; on heating, somewhat more soluble.	Almost complete precipitation, dirty violet, filtrate pale violet.	Dark blue-violet precipitate, filtrate pale red-violet.
Tannin reagent	Complete precipitation, dark blue.	Complete precipitation, blue-black.	In the cold, complete precipitation dark blue; on heating, a trace is soluble.
Alum	Partial precipitation, dark blue.	Slight violet turbidity.	Slight blue precipitate, filtrate violet.
Potassium bichromate	In the cold, complete precipitation greenish-black; on heating, partially soluble, filtrate olive.	Complete precipitation, brownish-black.	Reddish-black precipitate.
Ferric chloride	In the cold, a slight reddish-blue, precipitate; on heating, a greyish-black precipitate.	Violet turbidity, filtrate in the cold brown-violet; on heating brown, turbid.	In the cold, violet turbidity; on heating, dirty claret-red turbidity.
Mercuric chloride	In the cold, complete precipitation dark blue; on heating, partially soluble.	Complete precipitation, blue-violet.	In the cold, complete precipitation violet; on heating, the precipitate becomes bluer, filtrate red-violet.
Stannous chloride	Partial precipitation, dark blue.	Blue-violet precipitate, filtrate pale red-violet.	Slight blue-violet precipitate, filtrate red-violet; on heating more soluble.
Calcium hypochlorite	In the cold, complete precipitation dark brown; on boiling, precipitate becomes powdery, brown-red.	Rapidly becomes paler, brown-violet, complete precipitation reddish-grey; on heating decolourised.	On standing, brown precipitate, filtrate colourless; on heating, almost clear, colourless.
Zinc powder and ammoniacal solution	Decolourised, filtrate at once becomes blue.	Easily reduced, filtrate rapidly becomes pale violet.	Easily reduced, colourless; filtrate at once becomes violet.
Zinc powder and acetic acid solution	Reduced, yellow-brown; filtrate becomes green on shaking.	Reduced on boiling, filtrate yellowish, on shaking becomes brownish, then dirty violet-red.	Easily reduced, greenish, filtrate at once becomes violet-bordeaux.

	New Fastblue 2B	New Fastblue 3R	Methylene Blue DBB
Colour	Dark olive-brown powder.	Greenish-black powder.	Small pieces, with greenish metallic lustre.
Solubility in Water	Reddish-blue solution.	Violet solution.	Readily soluble.
Solubility in Alcohol	Dark blue solution.	Violet-red solution.	Readily soluble.
Solubility in Ether	Insoluble.	Insoluble.	Insoluble.
Solubility in Benzene	A trace is soluble, pink.	Insoluble.	Insoluble.
Heated on platinum foil	Emits a reddish-grey vapour swells up, giving a carbon which burns away leaving very little ash.	Melts, swells up and emits a bluish vapour, giving a carbon which burns away leaving but little ash.	Emits a greenish, then a white vapour, burns with a very smoky flame giving a porous dark grey mass, which burns away with great difficulty leaving no ash.
Concentrated sulphuric acid	Solution dark olive, diluted blue, on standing partial precipitation blue; on heating blackish, diluted pink.	Greenish-blue solution, diluted violet; on heating greenish-black, diluted pink.	Dissolves with effervescence, solution grass-green; diluted with water: blue solution; on heating the conc. solution becomes dirty olive, then blackish.
Dilute sulphuric or hydrochloric acid	In the cold, partial precipitation blue; on heating, clear solution.	Unchanged.	Unchanged.
Dilute nitric acid	In the cold, partial precipitation blue; on boiling, almost clear, dark ruby-red.	Violet-red solution; on boiling, not altered.	On boiling, blue-green.
Sodium hydrate	In the cold, almost complete precipitation red-brown, filtrate greenish-yellow; on heating, mor esoluble, filtrate brown-red.	Solution becomes olive; in the cold, slight brown turbidity; on heating clear.	Violet-blue solution; extracted with ether, bluish-red solution.
Ammonia	In the cold, almost complete precipitation red-brown, filtrate brown-yellow; on heating, more soluble, filtrate brown-red.	In the cold, partial precipitation brown, filtrate red-brown; on heating, more soluble, filtrate dark brown.	Unchanged; extracted with ether red solution.
Sodium carbonate	In the cold, almost complete precipitation dark brown-violet; on heating, more soluble, filtrate dirty red.	In the cold, almost completely precipitated blue-green, filtrate greenish; on heating, more soluble, filtrate olive.	Unchanged.
Tannin reagent	In the cold, complete precipitation dark blue; on heating, somewhat soluble.	In the cold, complete precipitation dark violet; on heating, somewhat soluble.	Quantitative blue precipitate; on heating, somewhat soluble.
Alum	Partial precipitation, reddish-blue.	Unchanged.	Unchanged.
Potassium bichromate	In the cold, complete precipitation blue-black; on heating, partially soluble, filtrate ruby-red.	In the cold, complete precipitation brown; on heating, partially soluble, filtrate brown-red.	Quantitative red-brown precipitate; on heating, olive green, partly soluble.
Ferric chloride	In the cold, slight violet precipitate; on heating, dark blue precipitate.	Slight violet turbidity.	In the cold, unchanged; on heating, becomes green and turbid.
Mercuric chloride	In the cold, complete precipitation reddish-blue; on heating, partly soluble.	In the cold, almost complete precipitation brown-violet; on heating, mostly violet soluble.	Splendid violet quantitative precipitate; on heating, blue, and slightly more soluble.
Stannous chloride	In the cold, almost complete precipitation blue, filtrate bluish; on heating, greenish precipitate, filtrate steel-blue.	In the cold, almost complete precipitation reddish-blue; on boiling, decolourised.	Quantitative, dirty blue precipitate, which on heating becomes colourless.
Calcium hypochlorite	In the cold, complete precipitation red-brown; on boiling, precipitate becomes powdery, yellow-brown.	In the cold, complete precipitation dirty violet; the precipitate slowly disappears on standing, quickly on heating.	Unchanged.
Zinc powder and ammoniacal solution	Decolourised, filtrate at once becomes dark pink, with acetic acid blue.	Decolourised, filtrate pale reddish, with acetic acid violet.	Quickly reduced; the filtrate and the edges of the filter-paper rapidly become violet.
Zinc powder and acetic acid solution	Reduced, greenish; filtrate becomes blue-grey on shaking.	Decolourised, filtrate at once becomes violet.	Easily reduced; filtrate and edges of the filter-paper rapidly become blue.

		Toluidine Blue	Brilliant Green crystals extra	Malachite Green crystals extra
Colour		Dark olive-green powder.	Yellow-olive crystals with metallic lustre.	Green crystalline plates with metallic lustre.
Solubility in	Water	Blue solution.	Readily soluble.	Readily soluble.
	Alcohol	Blue-violet solution.	Readily soluble.	Readily soluble.
	Ether	Soluble in traces, pink.	Soluble in slight traces.	Soluble in slight traces.
	Benzene	Insoluble.	Soluble in traces.	Soluble in traces.
Heated on platinum foil		Melts, swells up, emits much vapour and a strong odour, and leaves a good deal of ash appearing yellow when hot, white when cold.	Melts, and burns with a very smoky flame, giving a black carbon, which rapidly burns away leaving no ash.	Melts, and burns with a very smoky flame; the carbon burns away rapidly, leaving a good deal of white unfused ash.
Concentrated sulphuric acid		Green solution, diluted blue-green; on heating violet-black, diluted red-violet.	Dissolves giving dark yellow solution, orange-red at the edges; diluted with water brownish-yellow, pale-yellow; on heating, the conc. solution becomes dark yellow-brown.	Dissolves giving dark yellow solution, orange-red at the edges; diluted with water: brownish yellow, pale yellow; on heating, the concentrated solution becomes darker, yellow-brown.
Dilute sulphuric or hydrochloric acid		Unchanged.	Orange-yellow solution; on heating, becomes pale dirty yellow.	With sulphuric acid: red-brown solution, in a thin layer yellow; on heating, in a thin layer, olive; with hydrochloric acid the same but paler.
Dilute nitric acid		In the cold, unchanged; on boiling, dark greenish-blue.	In the cold, same as with dilute sulphuric acid; on heating, paler; after long boiling finally becomes turbid and pale yellow.	In the cold, same as with dilute sulphuric acid; on heating, paler; after long continued boiling the liquid becomes turbid and pale yellow.
Sodium hydrate		In the cold, almost complete precipitation brown-violet, filtrate pale violet; on heating, mostly dissolves, violet solution.	Pale green quantitative precipitate; on heating, becomes pale chamois. Extracted by ether giving pale yellow solution.	Dirty pale green precipitate, quantitative; on heating, colourless, extracted by ether giving pale yellow solution.
Ammonia		Slight dark violet precipitate, filtrate violet.	The solution becomes turbid milky, and finally milk-white; on heating, pale chamois; the precipitate is extracted with ether giving pale yellow solution.	The solution becomes milk-white, turbid, even on heating; filtrate turbid; extracted with ether giving colourless solution.
Sodium carbonate		Partial precipitation dark violet, filtrate blue-violet.	In the cold almost quantitative green precipitate; on heating, becomes pale chamois, filtrate turbid.	In the cold, unchanged; on heating turbid, becoming milky (white), filtrate turbid.
Tannin reagent		In the cold, almost complete precipitation dark blue, filtrate green. On heating, more soluble, filtrate blue-green.	In the cold, almost quantitative precipitate; on heating, somewhat soluble.	In the cold, almost quantitative precipitate; on heating, somewhat soluble.
Alum		Unchanged.	Unchanged.	Unchanged.
Potassium bichromate		In the cold, complete precipitation, dark brown; on heating, almost clear green solution.	Almost quantitative dark green precipitate; on heating, partly soluble; the liquid becomes covered with a coppery iridescent film.	Almost quantitative dark green precipitate; on heating, partly soluble; the liquid becomes covered with a coppery iridescent film.
Ferric chloride		In the cold, unchanged. On heating, turbid, blue-green.	In the cold, olive coloured solution; on heating, turbid brown-yellow, filtrate turbid.	In the cold, green solution; on heating, turbid brown-yellow, filtrate turbid.
Mercuric chloride		In the cold, complete precipitation; on heating, almost entirely dissolved blue-violet.	In the cold, and also on heating, partial precipitation.	In the cold and also on heating, partial precipitation.
Stannous chloride		In the cold, almost complete precipitation pale blue; on boiling, decolourised.	In the cold, quantitative green precipitate; on heating, soluble dirty green; filtrate pale yellow-olive; precipitate white.	In the cold, quantitative green precipitate; on heating, mostly dissolved, filtrate dark green.
Calcium hypochlorite		Complete precipitation, brown-violet.	Milky turbid, pale greenish, then white; filtrate colourless.	Milky turbid, bright pale greenish, then white; filtrate colourless.
Zinc powder and ammoniacal solution		Easily reduced, colourless; filtrate at once becomes red-violet.	Filtrate colourless.	Filtrate colourless.
Zinc powder and acetic acid solution		Easily reduced, colourless; filtrate at once becomes pale blue.	Reduced with great difficulty (only on long boiling); filtrate colourless.	Reduced with great difficulty; filtrate colourless.